METAL PROGRESS

ASST

"I keep six honest serving-men
(They taught me all I knew);
Their names are What and Why and When
And How and Where and Who."

RUDYARD KIPLING

6 HONEST SERVING-MEN

WHAT . . . . WHY . . . . WHEN . . . . HOW . . . . WHERE . . . . WHO

We know a man who still persists in the worn-out misconception that it is an admission of weakness to ask for information.

Fortunately for the progress of the metal industry, members of the A. S. S. T. nourish no such handicaps to advancement.

In January, February, and March of 1933, for example, 3372 requests for booklets and printed data were received at the Cleveland office and distributed to Metal Progress advertisers.

Inquiries such as these are helpful in three ways. They help the inquirer through the information thus secured. They help the advertiser by permitting him to disseminate his sales-story. They help Metal Progress by demonstrating to advertisers the attention it receives from readers.

This is a period when the Open Mind is vitally necessary to every phase of industrial activity.

Use your six serving-men—*what* . . . . *why* . . . *when* . . . *how* . . . *where* . . . *who* — and let them assist you to the maximum. Tell us what type of information you would like. We will do our best to locate it for you.

AMERICAN SOCIETY FOR STEEL TREATING

METAL PROGRESS

Metal Progress

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Ernest E. Thum, Editor

MAY, 1933 VOL. 23, No. 5

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OXY-ACETYLENE
WELDING & CUTTING

LINDE OXYGEN
. . . plants and warehouses in all industrial centers.

PREST-O-LITE ACETYLENE
. . . the standard for well over a quarter of a century.

OXWELD APPARATUS AND SUPPLIES
. . . available for every oxy-acetylene welding and cutting operation.

UNION CARBIDE
...sold in the familiar Blue and Grey drum from over 250 warehouse stocks.

Oxwelded Construction Dispels the Shadow of Maintenance

In Carrier Bodies

To the transportation industries oxwelded fabrication of carrier bodies has brought lightness combined with ample strength. The use of these lighter weight units has decreased wear and tear on equipment and, additionally, the welded joint materially limits the number of potential starting points for corrosion. Case No. 4193**

In Display Signs

By oxwelding, a fabricator of large sheet metal signs eliminates cracking of the enamel over joints or fastenings, as is often encountered in the use of other methods of jointing. Creeping joints, which are caused by expansion and contraction of overlapping edges with temperature changes, are avoided. Joint corrosion is practically eliminated. This assures greater life to the sign. Case No. 1527**

In Sugar Pans

Redesign for fabrication of sugar pans by oxy-acetylene welding not only lowered the first cost but actually eliminated failures and the attendant maintenance. Formerly, these pans were riveted and, since they were subjected to severe pounding in service, maintenance was a considerable item of cost. Oxwelded sugar pans are stronger and better fitted for their work. Case No. 4289**

In Corrosion-Resisting Specialties

Fabrication of Monel metal for liquid measures, scoops, scrapers and other specialties by oxwelding assures a permanently strong joint as resistant to corrosion as though the article were formed of a single piece. This assures longer life. Case No. 4048**

In Gasoline Piping

Graphically, a single drop per second amounts to 396 gallons per year—fuel for 8,000 miles of travel, when the drip is from a gasoline line. With every joint oxy-acetylene welded, this factor of leakage is eliminated. Oxwelding produces a dependable, tight, repair free joint—a joint that is really not a joint but rather a continuation of the pipe itself. It requires no maintenance. Case No. 4975**

In Dual Service Piping

The apparently solid floor of a large skating rink actually is honeycombed with thousands of feet of small diameter piping firmly embedded in concrete. This piping carries refrigerated brine for freezing the skating surface, or, if the arena is to be used for other purposes, steam for melting it. No mechanical joint could withstand the repeated contraction and expansion and remain tight. The architect specified oxwelding for all joints and thus assured a permanent installation entirely free from maintenance. Case No. 4173**

For Your Sales Department

Oxwelded construction is emphasized as a definite selling point in the current advertisements of many metal products. The reason for this is that industry, as a whole, recognizes that step by step the items that induced the designer and producer to utilize oxy-acetylene welding make more than a proportionate contribution toward the greater saleability of the product. Today, with the shadow of maintenance very definitely a deciding factor in every industrial and consumer purchase, it is good salesmanship to point out the vastly greater freedom from maintenance expense inherent in oxwelded construction.

**If any of these salient features are applicable to your product or if they suggest that redesign for oxwelding can make your product easier to sell and you want additional details, refer the case number to the nearest Linde District Office. The vast experience of The Linde Air Products Company in the development and application of the oxy-acetylene process can be made of very real value to you. Write or 'phone today.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

126 Producing Plants — UCC — 627 Warehouse Stocks

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LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES • UNION CARBIDE

Times Wide World Photo

Akron in Flight

Editorial

In Memory of the Akron

THE AKRON is down, and the Navy prepares to carry on with the Macon, remembering the traditional cry — "The King is dead; long live the King!"

Others do not share this confidence. The record made by dirigible balloons is not impressive. Neither is the parallel between balloons and kings exact; although man is mortal, his fading life is carried on by the younger generation. It is thus with all life that has adapted itself to its environment.

Others do not share this confidence for they have grave doubts whether it is possible to adapt these huge airships to their environment. If rigid dirigibles are made strong enough to survive storms that attract little notice on land or sea, they will probably be too heavy to fly, or at least to fly far.

Possibly a small dirigible could have weathered those winds that wrecked the Shenandoah and the Akron. A small ship might not be long enough to straddle a down draft while both ends were being blown upward; it would be thrown violently about like a leaf and might crash, but not be broken in two in the air.

Shortly after the R-101 was wrecked in France an editorial in METAL PROGRESS ventured the opinion that it would be well for aeronauts to learn how to design and fly small ships, before building and wrecking such large ones. This opinion of an inexpert observer is worth restating, although it is sure that small dirigibles are not of much interest to big-Navy experts. Airships must be big to have large lift — that is, to be able to carry enough fuel for long cruises. (Far distant reconnaissance is their part in warfare.) But here comes the dilemma: The bigger they are the larger and more indeterminate are the stresses due to turbulent atmosphere. The longer the cruise, both in distance and in time, the more liable they are to run into unpredictable storms. Hence the bigger they are, and the farther they fly, the more unlikely they are to get back.

On such general considerations as the above, there will be much support to a proposal that the United States follow the lead of Great Britain in abandoning large dirigibles as instruments of national defense, and invite other nations to sign a general agreement to put that resolve into an item of international law.

It is of course understood that, as stated each month on page 1, the editorials are written by the editor and do not represent the official views of the American Society for Steel Treating.

Expanding Markets for Metal

AN enthusiastic steel salesman the other day said he was getting a lot of new orders, and was unable to see why this new business was appearing, yet his company had to light some furnaces to take care of the demand and had to send some trucks out to get necessary firebrick.

Perhaps the refractories man found his stock so low he had to get in some more raw material, and ordered in a few carloads of silica rock and fireclay. But the excavator out in the pit was in bad repair and needed some new parts, so a requisition was sent to the manufacturer, who in turn had to wire to the steel company for some forging bars.

That's where business comes from!

• • •

IT IS true that new uses for sizable tonnages of steel appear from most unexpected places. For instance: One bright spot last winter for the producers of high chromium stainless sheet

was New England. It appears that this alloy has rejuvenated the oil burner industry, given a very important outlet for a petroleum by-product closely akin to the old-fashioned coal oil, and has correspondingly reduced the market for coal, expensive by reason of a long freight haul.

Smelly oil stoves and oil heaters have been with us for years. To be efficient the flame should heat a grille of metal to incandescence; most of the radiation comes from here. But in the past, no one knew how to make a metal screen that would last more than one summer's cooking. So the owners could not get very enthusiastic about their oil stoves. Made of heat resisting chromium steel sheet the burners are now as permanent as any other part of the device.

Who would think that such a homely device would take tons of expensive alloy in the middle of the world's worst depression?

* * *

BEER is touted as an aid to the metal industry. We guess that the effect is indirect. That is not to say that orders will be signed when the consignee is beered up, but that fine metal will go into the distributing end and into auxiliaries rather than into breweries — at least at present.

This idea is better conveyed photographically on page 32. Brewers will be inclined to revamp old breweries conservatively with pre-War materials of construction and get along on past experience until their cash balances permit them to make some experiments with other devices having interesting possibilities.

New Uses for Copper and Silver

IN ANY unstable economic period, such as the one through which we are now passing, when bank deposits are "frozen" and when the available currency is threatened with inflation (that is, shrinking purchasing power), the citizen who might be inclined to hoard his cash, if any, is puzzled what to do and still be safe. The standard advice is to buy something — anything — convert money of uncertain value into stable goods. (Of course, when this happens on a large scale, trade increases enormously and the main object of the inflationists is secured, even at the cost of those thrifty souls who have laid up money against the future in savings banks, insurance policies, and trust funds.)

One economist advises the puzzled citizen with ready money to buy copper wire bars. The price per pound is unbelievably low; the metal can be stored in your own cellar without damage by fire, flood, or earthquake; the bars weigh too much to invite pilfering; the metal is an essential commodity, and discovery of a cheap substitute is improbable. Consequently the real value will remain after one, ten, or a hundred years.

Few have followed his advice. The price of copper is still near its historic low.

Silver is in a similar market position. Even in its present debased condition, it costs many times as much as copper and therefore is not as suitable for individual investment. Rumor has it, however, that some far-seeing chemical companies are quietly putting a considerable amount of it into equipment for manufacturing pure caustic and other C. P. chemicals. Thus it is useful at present for its high heat conductivity and corrosion resistance, and undoubtedly at some future time will have a scrap value considerably higher than its present cost new plus interest in the meantime.

While silver is quite malleable, it is also weak, and must usually act as a liner inside a steel support. It is easy to line a pipe length, say, by merely flanging out the two ends of a silver tube to act as a gasket between bolted flanges. It is not so easy to attach a liner inside a sizable vat or autoclave, tight enough so it stays put, yet loose enough to provide for large differences in expansion on heating. Who knows how to do this?

DATA sheets in this issue and those appearing in February and April are parts of one complete piece of work by men at Aluminum Research Laboratories, New Kensington, Pa. Together with the text by Messrs. Keller and Wilcox on page 45 of last month's METAL PROGRESS, they comprise a systematic method of distinguishing the many intermetallic compounds and constituents existing in commercial aluminum alloys.

Cast Iron as an Engineering Material

By H. BORNSTEIN
Deere & Co.
Moline, Ill.

Conveyor in Westinghouse Continuous Foundry

THE TERM "CAST IRON" JUST LIKE THE term "steel" covers a wide range of engineering materials. To many of us cast iron is just "cast iron," a material low in price and short on physical properties. We forget that in many services cast iron is the best material which can be used for the purpose regardless of price. Furthermore, just as there are many kinds of steel, so there are many more kinds of cast iron. Under such circumstances it would be well to introduce this discussion by a definition of the term.

There are many such definitions, but a really satisfactory one is yet to be found. We may say, however, that cast irons are alloys of iron, carbon, and silicon, containing so much carbon (over 2.0%) that they are not ordinarily malleable, as cast, at any temperature. There are at least four common kinds, not including the special irons:

1. *Pig iron*, which is the product of the blast furnace and is either remelted and cast (producing gray or white iron) or it is refined in the steel making processes.

2. *White cast iron*, which contains nearly all of the carbon in chemical combination with the iron. The presence of this iron carbide (cementite) makes the metal hard and brittle. White iron can be classed according to the process. It may be produced by adjusting the composition (as by a low silicon content) or by rapid cooling. Chilled cast iron is produced by casting the iron against metal chills; such iron when cast in sand molds may have a gray fracture, but the chills cause rapid cooling and retain cementite.

3. *Malleable cast iron*, which is the term applied to castings in which all the combined carbon of the white cast iron has been changed

to free carbon (temper carbon) by suitable heat treatment.

4. *Gray cast iron*, which obtains its name from its characteristic gray fracture. Under the microscope it is found to contain very little free cementite. It is composed of ferrite, pearlite, steadite and graphitic carbon flakes. Structurally it is very complex, although it may be likened to a steel containing thousands of small graphite flakes. The matrix, or metal surrounding the flakes, is weakest when it is all ferrite and strongest when it is all pearlite. However, the strength of the metal is more affected by the quantity, size, shape, and distribution of the graphite than by any other factor.

In what follows I shall confine myself largely to the subject of gray cast iron.

Strength of Gray Iron Castings

It is difficult to set up a classification or a series of classifications for cast iron which would adequately cover the desired properties in the casting. In some cases, strength is the principal need, while in many others cast iron is selected for its hardness, wear resistance, resistance to shock, machinability, heat resistance, or corrosion resistance. Frequently the properties desired cannot be fully described in terms of test results, and control tests are specified.

Wherever possible, physical test properties should be specified instead of chemical composition. This recommendation is made because one foundry may use a certain range of composition to secure certain physical properties while another foundry would find it more convenient — due to differences in raw materials and melting practice — to obtain these physical properties with a different range of composition. It is considered undesirable to specify *both* physical properties and composition — except when alloys are specified to obtain properties not readily measurable.

The American Society for Testing Materials recently has developed "Tentative Specifications for Gray Iron Castings, A 48-32 T," where strength is a consideration. In these specifications gray iron castings are classed according to minimum tensile strength of test bars as shown in the table above.

Class No.	Minimum Tensile Strength
20	20,000 lb. per sq.in.
25	25,000
30	30,000
35	35,000
40	40,000
50	50,000
60	60,000

In these specifications, transverse tests are optional. Three sizes of test bars are adopted in order to have one of them represent the thickness of casting being bought, as follows: a 7/8-in. bar (as cast) for castings with controlling sections 3/4 in. thick or less, a 1.2-in. bar for castings from 3/4 in. to 1.1 in.; and a 2-in. bar to represent metal in castings up to 2 in.

In previous specifications, test bars were supposed to represent the metal in the ladle, but it has been realized for a number of years that this viewpoint was unsatisfactory. The engineer is interested in the metal in the casting and not in the metal in the ladle. It is realized that it is frequently difficult to determine the size of the "controlling section." Comparative hardness tests of casting and test bar may be of value in this connection.

Furthermore the problem of internal stress arises. The effective strength of a casting is the difference between the ultimate strength of the material and the internal stress. Sound design and good foundry practice are necessary to keep these stresses at a minimum. Make the test on the casting whenever possible and compare it with the test on the bar; then you will have a good idea of the value of the test bar for that particular casting.

Value of Hardness Tests

I want to cite one case in which hardness tests were of great value in determining the strength of castings: We had a casting used as a structural part where strength was important, and some failures had occurred in service tests. We checked up on a large number of castings, including the failed ones, and found a definite relationship between hardness and the transverse and tensile strengths. We were then able to set a minimum Brinell hardness value and test all castings in production, which has eliminated the trouble.

Hardness of the casting frequently is used as a guide to strength, machinability, or wear

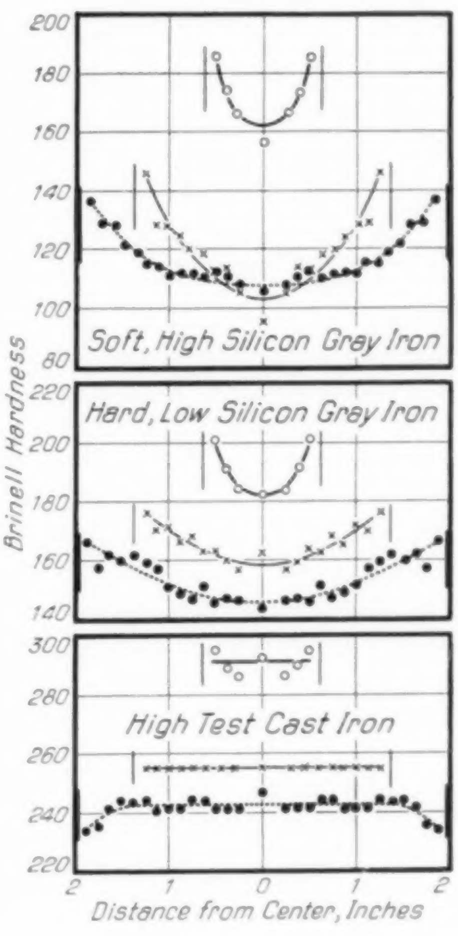
resistance. However, it is improper to classify by hardness alone.

The structure of a casting as shown under the microscope gives a good indication of physical properties. Care should be taken in selecting the samples to represent the casting. It is possible that classification of cast irons may be made on the basis of structure.

Cast iron is widely used in the engineering and allied industries because of the ease with which it may be cast sound. Its low cost and wide range of physical properties are also of greatest importance.

Tensile strength is regarded as one of the most important properties. Where tests are correctly made, the results are reliable and comparable. The tensile strength may readily be controlled within desired limits. Cast irons will range from less than 20,000 lb. per sq.in. for soft, weak iron to over 60,000 lb. per sq.in. for some of the high strength irons, especially if alloyed.

Compression strength of cast iron is usually several times the tensile strength and will range from about 60,000 to over 150,000 lb. per square inch.



Endurance limit will range from 40 to 55% of the tensile strength, depending upon the type of the cast iron.

Elastic Properties—Gray iron does not exactly follow Hooke's law (that the stretch is proportional to the load, within the elastic limit). Hence the modulus of elasticity is not a constant ratio, but ranges from 12,000,000 for the weaker irons to over 18,000,000 for the higher strength irons. There is no well-defined elastic limit, and the above figures are properly taken at a load equal to 25% of the ultimate strength. Gray irons can sustain static loads indefinitely up to 80% or more of their ultimate tensile strength.

Transverse test for strength and deflection is the most commonly used test for cast iron. Its principal utility is for foundry control rather than for design strength.

Impact resistance is a measurable property and depends largely on the form and quantity of the graphite. There is no standard test yet adopted, but a committee of the American Society for Testing Materials has been working on this problem for several years and has made thousands of tests covering a wide range of irons. A report will be made at the meeting of the A.S.T.M. in June.

Wear resistance is most important for various types of service. Gray iron is exceptionally free from any tendency to gall and seize, due to the self-lubricating action of the graphite flakes. Where resistance to severe abrasion is required, the hardness of the white or chilled iron is a desirable property. The properties in gray cast iron which are associated with a low rate of wear are pearlitic matrix, high hardness, and high strength. Other things being equal, an iron with a pearlite matrix will resist wear better than one containing free ferrite in the microstructure.

Comparing dissimilar irons, hardness does not have any relation to wear. However, for the same type of iron higher hardness frequently results in much lower rate of wear. Thus, for tractor cylinders, an increase of from 30 to 50 points in Brinell hardness proved very beneficial; the increased hardness and wear resistance were obtained by adding nickel and chromium in the ladle. There was no change in the machinability of the iron.

Hardness can be controlled within certain limits by the method of manufacture, composition of the iron, and rate of solidification of the casting. A wide range of hardnesses is to

Strength and Hardness of Iron D and Iron E

	0.75-In. Diameter Bar		1.2-In. Diameter Bar		2-In. Diameter Bar		3-In. Diameter Bar	
	Iron D	Iron E	Iron D	Iron E	Iron D	Iron E	Iron D	Iron E
Supports	12 in.	12 in.	18 in.	18 in.	24 in.	24 in.	24 in.	24 in.
Transverse strength	948 lb.	765 lb.	2,298 lb.	1,578 lb.	7,950 lb.	5,140 lb.	25,210 lb.	14,363 lb.
Deflection	0.185 in.	0.14 in.	0.25 in.	0.21 in.				
Tensile, lb. per sq. in.	37,375	28,825	36,870	23,590	30,900	15,420	24,540	12,100
Brinell hardness	248	241	235	235	212	187	179	137

be had by heat treatments, ranging from slightly over 100 Brinell for fully annealed cast irons to over 600 for certain chilled and heat treated iron castings.

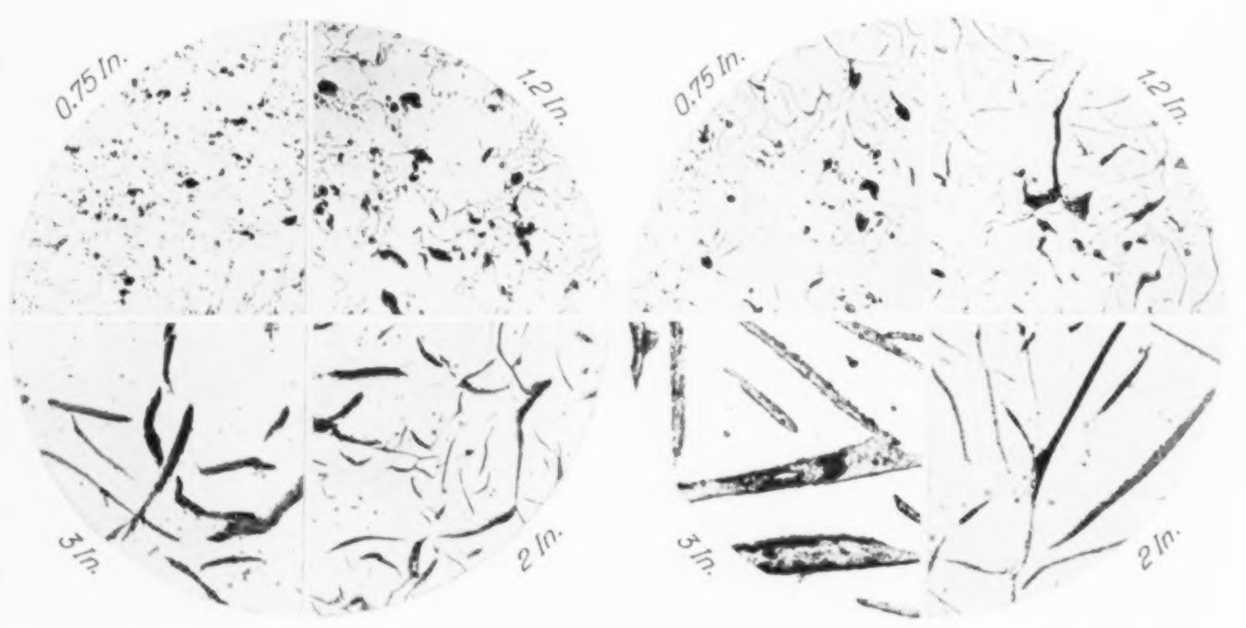
Corrosion — Special corrosion resistance may be induced by adding alloys and by the method of manufacture. A dense grain structure is of value. Chromium, nickel-chromium, copper, copper-molybdenum, and silicon have important effects. An austenitic iron containing about 15% nickel and 2.5% chromium has high resistance to many acids and alkalis. Other corrosion resistant alloys contain 18 to 30% chromium with or without 8 to 11% nickel. Silicon in the amount of 11 to 17% gives great corrosion resistance, particularly toward acids.

Heat Resistance — Ordinary cast iron will retain its strength (as determined by short time tests) up to 850° F. When gray iron is repeatedly heated above 700° F. it increases in size, which increase is permanent and more or less in proportion to the number of heatings and the temperature. Fine-grained irons with more stable carbides are more resistant to such growth. Elements that tend to stabilize carbides will retard growth.

Chromium, nickel-chromium, molybdenum, and silicon have been of value for improving the heat resistance. For temperatures up to 1800° F. cast irons containing 14 to 30% chromium are useful. A recent development of the British Cast Iron Research Association is a cast iron with 6 to 8% silicon. A modification of this is a high silicon austenitic iron containing 6% silicon and 18% nickel. Another austenitic iron contains about 6% silicon, 13% nickel, and 2% chromium.

Machinability is a most important property of cast iron and is not readily measurable. As pointed out by Mr. Palmer in METAL PROGRESS

Irons "D" and "E"; 100 Diameters; Unetched



last month, one shop may consider an iron machinable while the next shop will find it unsatisfactory. Machinability ranges are wide and cast irons may be made to suit any condition, remembering that ease in machining is usually inversely proportional to the strength of the casting. Additions of alloys such as nickel, chromium or molybdenum have specific effects, as do also chilling and heat treatment.

Magnetic Properties — Various cast irons may be used for high permeability, permanent magnetism, or non-magnetic properties, depending on specific services required. An example of a non-magnetic cast iron is one containing 12% nickel and 6% manganese.

Mass Effect — Mechanical properties such as tensile strength, transverse strength, endurance limit and hardness vary considerably with change in section. An iron which may be very soft and easily machinable when poured into a heavy casting may be quite hard and difficult to machine in a light casting. Hence the composition must be adjusted for the size of section.

This difference in physical properties due to mass effect is greater for the lower strength irons than for the higher strength irons. This is well shown by the accompanying microstructures of round cast bars from ¾ in. to 3 in. diameter cast from the same ladle of iron. Tensile test bars were machined from the centers of each; results are shown on the table at top of the opposite page. Iron *D* is used for tractor castings, and 12% of steel was used on the charge; iron *E* is used for some farm implement castings, and no steel was used on the charge.

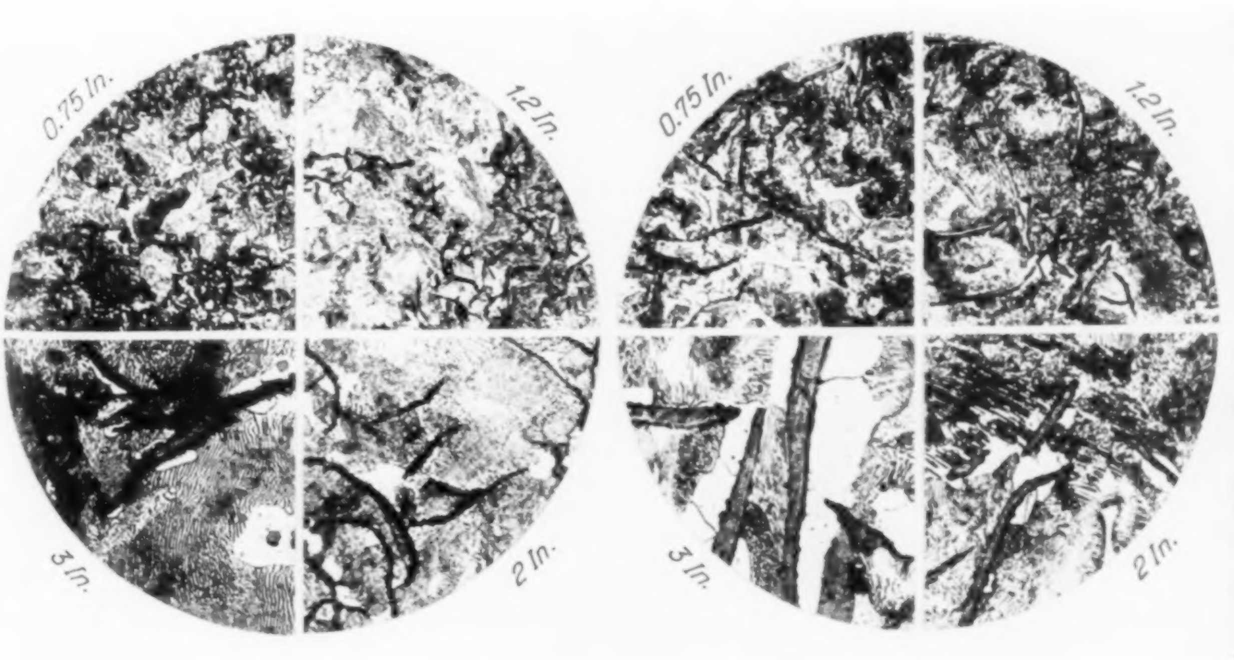
R. S. MacPherran has also conducted some experiments to show the hardness of various sized sections of soft iron, hard gray iron, and high strength iron. The analyses were:

	Soft	Hard	High Strength
Total carbon	3.42%	3.60%	2.55%
Silicon	2.23	1.29	2.23
Sulphur	0.084	0.121	0.096
Phosphorus	0.54	0.21	0.08
Manganese	0.70	0.78	0.86
Nickel			1.43

His results are shown in the curves on page 21. Each set of curves records the variation in hardness, center to edge, of a 1¾-in., 2¾-in., and 4-in. round bar; the vertical lines at the ends of the curves represent the surface of the test bar. It will be noted that with increase in strength, mass has less effect.

The above mentioned work of MacPherran and the author was done for Committee A-3, A.S.T.M., and the details were published in that society's *Proceedings* in 1929 and 1931.

Irons "D" and "E"; 250 Diameters; Etched With 2% Nital



Welded Plate for Furnace-Work

By GEORGE B. CRAMP
Coatesville, Pa.

A Contribution to the Lincoln Arc Welding Competition

When heavy machinery developed from cast iron to cast steel, little change in design or manufacture was necessary during the relatively slow transition. Fabrication of welded plate, on the other hand, is not a short step in advance, but a complete departure from previous practice. Some well-defined rules of engineering design must therefore be recognized, in order that the new method may be economically adopted and favorably received.

The first decision to be made is that the entire machine or structure (and not parts of it alone) is to be of welded construction. The next important decision to be made is that cast designs must not influence the welded design. The third decision is to discard the use of rolled structural shapes, except steel plate and steel pipe. Bent, formed, pressed, or forged shapes are likewise to be avoided. The ideal, of course, is to use no tools except gas cutting blowpipes and arc welders.

Three years' experience at Lukens Steel Co. on dozens of different pieces of steel-mill machinery, furnaces and appliances indicates that this ideal can be approached, despite the fact that nearly always but a single one was on order. Furthermore, the machines and structures have usually been produced in less time than formerly. Nearly all of these machine parts and structures have now been in existence a sufficient period of time, some of

Courtesy Westinghouse Electric & Mfg. Co.

them nearly four years, to prove not only that the theory of design applied is correct, but that the constructions are permissibly lighter in weight, greater in strength, and superior in wearing quality.

The engineer and designer must first realize that all equipment may be regarded as an assembly of elements, such as bearings, wheels, gears, drums, frames, brackets, ties, bindings. If the basic design of these is well in mind, composite assemblies are then a logical development.

As to raw material: Steel plates are now available in thicknesses from ½ in. up to 2 in. which have been rolled from sufficiently large ingots so that they have uniformly good properties and high tensile strength. When greater thicknesses are specified, lower stresses must be allowed.

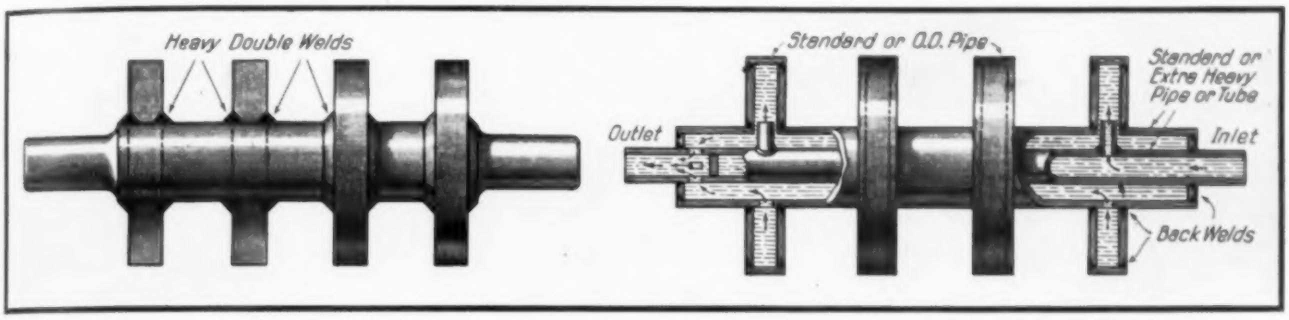
If stresses of from 2000 to 6000 lb. per sq.in. are allowable for cast iron and from 6000 to 12,000 lb. for cast steel, then 12,000 to 20,000 lb. per sq.in. should be permissible for welded steel plate unless such parts will be subject to heat, which will of course lower the allowable stress for any of the materials.

The first step in fabrication after the design and material reach the shop is to cut the desired shape with an oxy-acetylene flame. This may be performed by hand, or more rapidly and accurately by use of machines set to cut circles or odd shapes automatically. With the "radiagraph" it is possible to cut holes as small as 1 in. diameter to within $\frac{1}{16}$ in. of the true size through plate 2 in. thick or less. This automatic cutter may also be set to cut a beveled edge on either the outside or inside periphery of a ring so that the diameters of each bevel will be concentric to within $\frac{1}{8}$ in. for plate thicknesses of 3 in. and less. Such close limits are sufficient for many heavy sections, and represent but a moderate machining allowance when closer dimensions are required.

As an illustration of one of the many machine units that have been studied, converted to welded construction, and welded by the Lukens organization, let us briefly look at rollers. Rollers are particularly applicable to rolling mill machinery, and are a machine element wherein the correct principles may be readily applied. Two typical forms are shown in the drawing above.

The disk roller is for heavy plate mill and blooming mill tables. In the former mill the disks carry the plate on the edge or rim, and this rim becomes much hotter than the shaft. Heavy welds are therefore necessary to withstand the expansion stresses, and the disks should also be bored for a shrink fit. When used on a blooming mill the bloom will travel in the grooves and the entire roll is more uniformly heated. The welds shown will be ample for any side thrust.

Plain rollers are more common for run-out tables. They are very simple, consisting of a piece of heavy pipe of proper diameter cut to length with end heads or hubs welded in. Both heads should be keyed to the supporting shaft, one end anchored with a countersunk weld, the other having a sliding fit over the key to take care of expansion.



Flexibility of Welding Method Illustrated by Extremes in Steel Mill Table Rollers

Water-cooled rollers — in fact, water-cooled equipment generally — can be welded with the utmost facility. The design shown is constructed entirely of pipe and a few disks. The inner pipe is a manifold with branches leading into each compartment; the latter are properly baffled to require the water to flow in the desired direction. Usual glands or swivel connections are provided at inlet and outlet ends. Note that all welds are back welds (countersunk) in order that the thickness of all metal sections may be uniform.

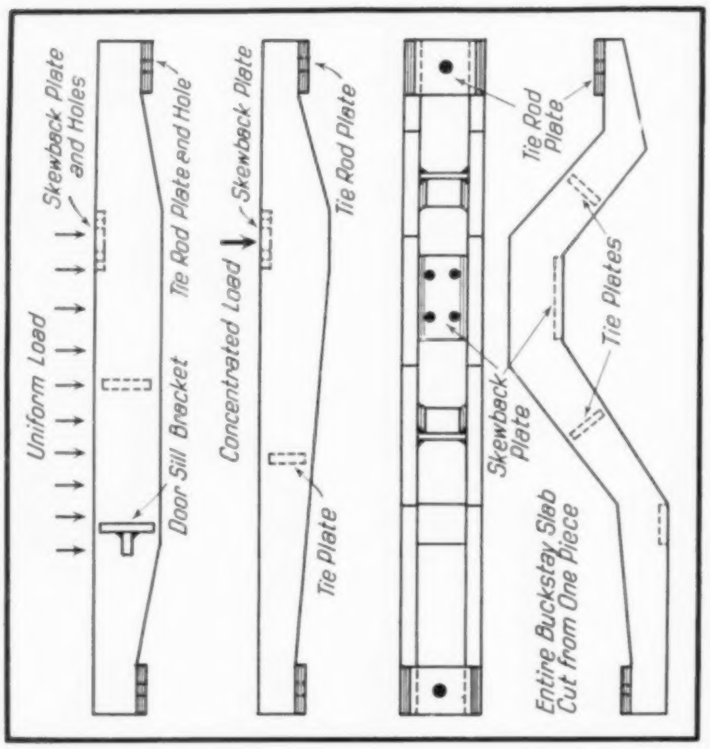
While such water-cooled equipment is obviously adaptable to many furnace accessories, and was one of the earliest applications of welding to furnace parts, it is less well known that in most cases structural steel work binding and buckstays may be advantageously replaced by steel slabs. The edge of a slab presents far less area in proportion to the bulk of the slab in direct contact with the refractory materials of a furnace than does the flange of a structural shape. In case a hot spot develops at the point where such binders are placed, the piece is subject to less damage and bending out of shape. This is a matter of importance since the life of a furnace roof is dependent upon the stability of the bindings.

Another advantage is that the slab may be cut to the economic lines of a beam of uniform strength — a plan not permissible in a struc-

tural shape, at least with economy. Representatives are shown in the figure below. The second from left is designed to take a thrust imposed by a flat arch of wide span. The right-hand type, shaped to the contour of the sloping back wall of an open-hearth furnace, should be cut so as to avoid sharp corners, particularly on the concave lines. Such variation in depth of beam avoids the use of "hog rods," and generally is more economical in space.

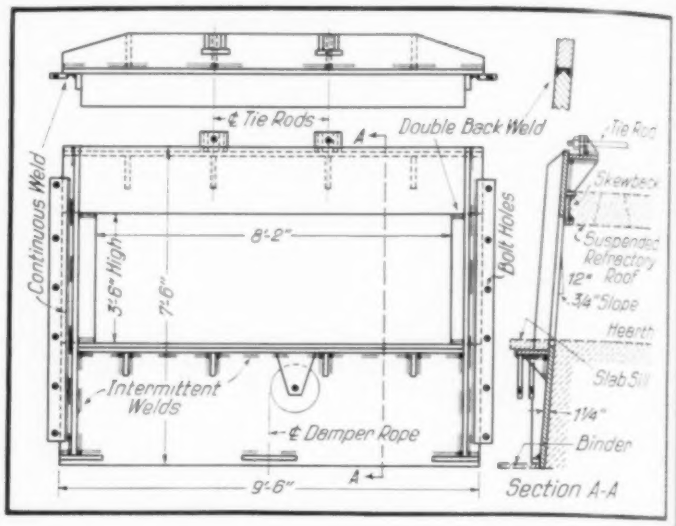
Binders may have seats welded on to form sockets for buckstay ends. Heavy bolts may also be attached at their ends, to provide adjustment conforming to expansion and contraction of the furnace brickwork.

Skewbacks made of structural shapes usually prove too light for large furnaces and heavy castings are preferred. Three steel slabs welded into a channel section, with bolt holes gas-cut in the field have many advantages. If one flange should be burned in service, it can readily be replaced, thus salvaging the greater proportion of the material. Low carbon steel plate is practically as resistant to heat as the conventional cast iron or cast steel skewbacks.



Buckstays of Slab Steel Are Readily and Economically Formed to Correct Contour

Typical Shop Drawing (Lacking Detail Dimensions) for Front Plate for Heating Furnace, to be Made of Welded Plate



It is not necessary to confine such materials to attachments for very large melting furnaces. Welded steel plate is also quite applicable to bindings for furnaces for heating and heat treating. A fallacy still persists that rolled steel is subject to such distortion by warpage in contact with heat that it is not a suitable material. This impression has been gained in most cases from the observation of the effects of heat on relatively thin plates or sheets, or on structures that have gone through a disastrous fire. When rolled steel plate is specified in equivalent thicknesses to what is usually provided in cast parts, properly welded and placed where it will not come in direct contact with high temperatures applied at local areas, this type of construction will be found to give most satisfactory service, as has been proved at Lukens Steel Co. time after time.

A practical application of these facts is shown in the drawings of a double ended heating furnace, with hearth 8 ft. wide, 12 ft. 6 in. deep and 3 ft. 6 in. high. Intermittent welds are adequate for most joints in this type of construction. Representative of the simplicity of the design drawings is the detail of the front plate. The lap piece at each end bolts into a corner post or stanchion, so the entire front is removable for major repairs. It is adequately ribbed at the top edge where it is tied to the back with two rods, thus giv-

ing the rigidity and strength of a beam. The lower edge is unstiffened, but projects down and back of a binder laid flat in front of it.

The furnace of which this is but a part is shown in accompanying views. The brick-lined door design is indicated. Its bottom ledge is considerably thicker than other members (for which ¾ in. is sufficient) as this part is usually the one which fails first by being burnt off or warped out of shape. A renewable slab sill is also provided on the top shelf or ledge of the furnace front plate. Two square openings are provided for inserting about six standard firebrick each, to act as keys for the door lining. This door, which is entirely satisfactory, is about 25% lighter in metal than one made of cast iron or steel.

Such parts are quite adaptable to the heating furnace of front and back door type, an arrangement which permits charging pieces into one door and withdrawing them from the other, or the one furnace may serve presses located on either side. Both sides of the furnace are therefore the same, except that the damper and operating rig is missing on one.

Doors are raised and lowered by a single air cylinder for each door, the cylinders themselves being made by a welding of extra strong pipe, and mounted on welded steel bases. They are supported on top beams at each end of the furnace; these beams are composed of two wide bars adequately stiffened with separators and welded together; this arrangement also provides a housing for the rope sheave wheels. The beams are in turn supported by brackets which are part of the stanchions (corner posts).

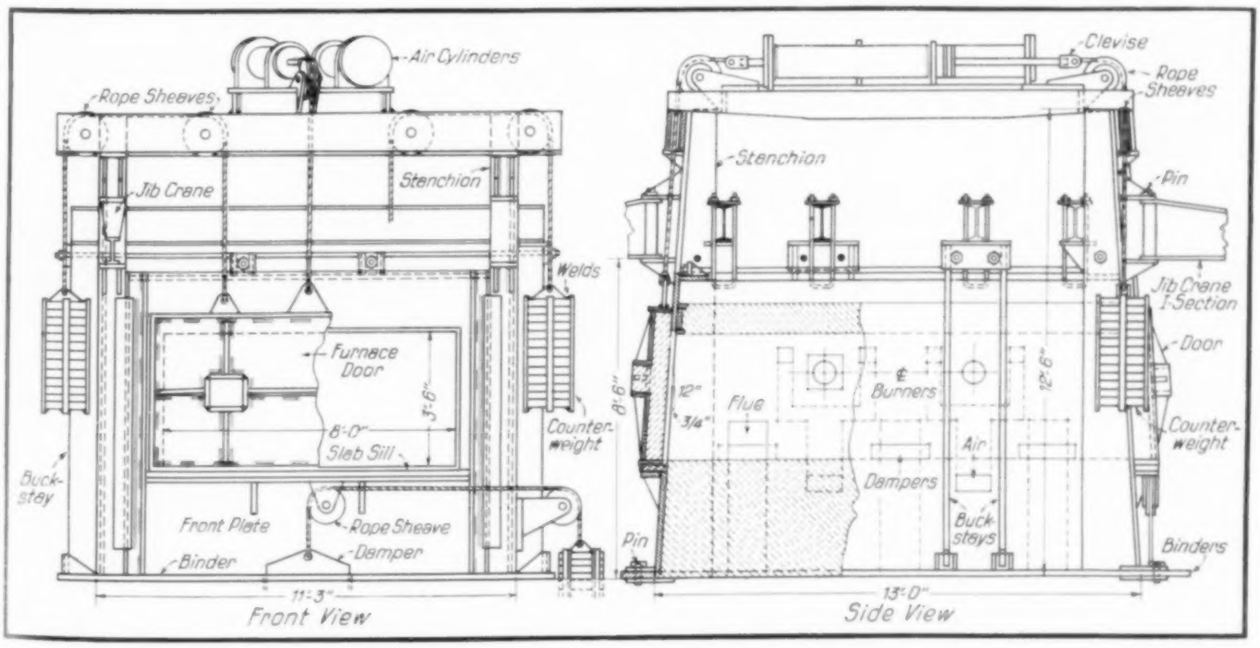
Two counterweights and rigs are provided for each door, thus properly balancing it. The arrangement for operating the damper is shown along with the brackets for the sheave wheels.

In sectional side elevation is shown more plainly the manner of carrying the door operating cylinders. Note also that brackets are welded to the corner posts for carrying the cantilever jib cranes.

Narrow slab buckstays serve a useful purpose in this design, as the burner and damper ports are so closely arranged that all room possible is needed between the buckstays. Both ends of the furnace slope toward the top so that the door (being always tilted in an inclined position against the front plate) effectively closes the opening.

The outstanding feature of the design of these furnace parts is that they have been constructed entirely of welded plate, no castings nor patterns whatever having been used. All structural work has likewise been eliminated, except that I-beams are used only for carrying the suspended furnace roof.

General Drawing of Heating Furnace With Front and Back Door and Flat Suspended Roof. Principal parts as labeled make maximum use of welded steel plate



Improved Seamless Tubing

READERS OF METAL PROGRESS HAVE been reminded more than once of the movements in the pipe and tube industry that have disturbed the equilibrium formerly maintained by butt-welded pipe, lap-welded pipe, and hammer-welded pipe. Seamless tubing was of course obtainable in the gay ninety's, but it was the product of the drawbench rather than of the rolling mills, and the cost was too high for widespread use.

Installation of Stiefel and Mannesmann piercing mills at the beginning of this century entirely changed this picture. The seamless product was gradually adopted for boiler tubes and high pressure piping. Mechanical tubing, so called, came into prominence for making machine parts, tools, and frames. This expanding outlet encouraged manufacturers to perfect their piercing and rolling mills, and they were eventually able to compete in the sizes between say 3½ and 6½ in. for purposes where welded soft steel pipe formerly had a complete monopoly. Generally speaking, this caused the older mills to reduce the prices of lap-welded pipe to a level where the newer and more complex mills could not follow.

This, however, did not end the troubles of the lap-welded industry. Small thin-walled tubing made of bent strip, edge welded either by oxy-acetylene flame or by electrical resistance, appeared on the market for low-pressure or no-pressure conduit. At the other end of the size range, plate was bent and edge welded (ordinarily by electric arc) into pipes 18 in. to 30 in. diameter, suitable for long trunk lines for oil and gas. This latter method of manufacture is extremely flexible, there being practically no upper limit to the pipe readily made with very simple equipment.

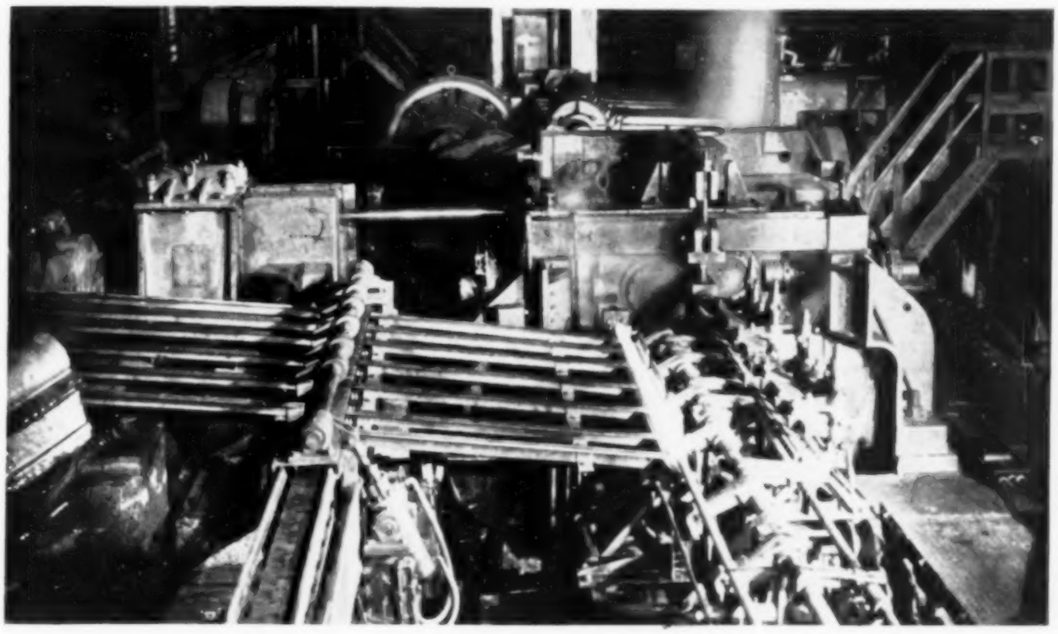
As a consequence of these various movements the pipe purchaser now may select from a variety of products. (Another way of stating the same fact is that the pipe manufacturer must meet competition from a variety of sources.) Without attempting great precision — for the boundaries are by no means fixed — the following approximate conditions obtain in today's market:

Butt-welded and lap-welded pipe mills are highly mechanized and specialized to produce pipe of 0.08 to 0.12% carbon bessemer steel ranging from ⅛ in. inside diameter by 0.070 in. wall thickness up to 20 in. outside diameter. It is still the general purpose pipe for handling oil, gas, water, or other non-corrosive fluids at moderate pressure and normal temperature, and is used with screwed fittings.

Resistance welded pipe, made by machinery described in METAL PROGRESS in September, 1930, offers strong competition to the above in all sizes because the process is able to weld stronger steels — carbon up to 0.30 or even 0.40%, and low alloy skelp — and therefore to make a tube with lighter walls. In small sizes particularly, inexpensive soft steel strip is a convenient raw material, and such small tubing is widely used for electric conduit, oil and gasoline lines at nominal pressures, and for machine parts. Sizes range from about ¼ in. outside diameter by 0.020 in. wall to 16 in. diameter.

Fusion welded pipe in the larger sizes may also use this higher carbon steel plate, unweldable by heat alone, and it has been widely adopted for oil and gas transportation, where pressures are high and weight of metal is to be economized. Field joints are welded or coupled rather than screwed.

Long Mandrel Bar Is Seen Entering Pierced Billet at Foot of Inclined Skids. Fingers then transfer it to right and it enters the elongating mill. End bearings of the work rolls flank the bell-mouthed guide, and the vertical disks (in line with the trough) acting as guides, are enclosed in the main housing



Seamless tubing requires a cleaner grade of steel, else the excessive punishment during fabrication will cause sizable defects to spread out from the inclusions. However, a large number of forgeable alloys have been converted into seamless tubing. It may also fairly be said that despite the excellence of present commercial practice, any *welded* pipe still retains many evidences of the joint, and this militates against use for high pressure, high temperature work, or for mechanical parts which are severely stretched or expanded during fabrication, or which must resist rapidly fluctuating loads. For such purposes, seamless tubing well warrants its additional cost. Present approximate limits in size for the hot rolled seamless pipe are 1¼ in. diameter by 0.156 in. wall up to 24 in. outside diameter.

Appropriate sizes of seamless tube form the raw materials for cold drawn tubes of any desired size and wall thickness down to hypodermic needles. This work is done piece by piece on a bench and requires so many auxiliary cleaning and annealing operations that cold drawn tubing can never compete in price with small sizes of welded pipe. Its use is only justified when there are certain collateral advantages to outweigh the higher cost per pound. Fortunately for the art, there are many such situations.

It is easy to understand how there may be a considerable overlap in the various fields, as roughly mapped out. Competition in recent years has become especially keen. Manufacturers have attempted in many ways to reduce their manufacturing costs and improve the quality and widen the adaptability of their product. Some have installed electric welding equipment in order to meet competition on an equal footing.

Babcock & Wilcox Tube Co., having specialized in seamless tubing of carbon and alloy steel, believed that there was even yet considerable opportunity to improve the conventional manufacturing technique, and thus turn out a better product at a lower cost. This ought to be the best way to meet the changing competitive situation. Apparently its experiments with the Diescher mill have had the desired result.

It will probably be well to refresh one's memory as to the essential features of the conventional piercing mill, or "automatic" mill, as it is called in the United States. Those wishing a more detailed explanation may turn to Mr. McNiff's articles in Metal Progress, May and June, 1931, or to Part IV of Camp & Francis'

Inner Surface of Right Hand Tube, Rolled Over Long Mandrel Is Free From Spiral Undulations and Longitudinal Scores

book "Making, Shaping and Treating of Steel."

In the typical mill a short round billet is deeply centered on the forward end, heated to the correct high temperature, and pushed endwise into the piercing mill. It is held in alignment by guides and gripped between conical rolls, inclined slightly to the center line of the mill table and guides, in opposite directions, and so shaped that they roll the hot metal up over a conical mandrel or piercing point in a spiral direction. The mandrel is held up to its work by a water-cooled thrust rod.

During this first or piercing operation considerable friction is developed between the hot metal and the guides, rolls, and mandrel. Guides and mandrel, being of small area, are badly punished, and their life between dressings is correspondingly short.

The economical limits for first piercing are generally restricted to about 4 in. internal diameter. Larger tubes up to say 8 in. have usually been made by expanding on a second mill similar to the piercer. Recent manufacture of large diameter seamless pipe starts with large billets and larger piercing mandrels in very powerful machinery. This article, however, has to do with the smaller sizes.

To make smaller tubes in a conventional automatic mill, the next operation after piercing is to reduce the outside and inside diameters nearly to finished size and to the exact wall thickness in a 2-high plug mill. It takes several passes, back and forth; the rolls are brought closer together on each pass, and the pipe is forced directly over a cylindrical mandrel or plug (this mandrel also being changed for a slightly larger one each time). The operation is now finished except for a pass through the reeler and a final pass through a sizing operation. Smaller diameters than are possible to produce by plug rolling may be obtained on what is known as a sinking mill.

This outline may possibly enable the reader to visualize the manufacturing plant which has been, until recently, considered thoroughly up to date, and yet which was to be improved, if possible. It already had had the advantage of 25 years of study, wherein much had been done for the quality of metal in the billets, for the design of heating furnaces, and in strengthening and refining the mills and auxiliaries. Yet there were some serious objections to the mill and some limitations to the product which it was desirable to remove — principally as follows:

1. An automatic mill required a heavy capital expenditure.

2. It lacked flexibility, to the extent that it could not produce tubes with thin walls, thereby necessitating the larger part of the present cold drawing operations on pipe.

3. The inside of the tube contained longitudinal score marks.

4. The tube could not be made sufficiently accurate and uniform to meet specifications of the automotive and aeronautical industries.

Faults in the tubing largely originated in the conventional plug mill. Dirt, oxide, or hot

metal is always caught or seized on the surface of the plug — itself not highly polished — and scores the entire length of the pipe. Ordinarily these score marks are light — a typical tube is shown in the left-hand view opposite. It should also be remarked that these light scorings have not led to any service failures in well-made tubes which have not been reduced much in a sinking mill. In other words, 3½ to 4-in. boiler tubes, conforming to A.S.M.E. or A.S.T.M. specifications, have a practically perfect record of performance over the past 25 years. It is only in sinking and cold drawing to much smaller sizes that the interior score marks are aggravated in depth and become dangerous.

Realizing the above-mentioned difficulties, Samuel Diescher and August Diescher proposed to eliminate the plug mill by rolling a pierced billet over a mandrel consisting of a long piece of loose shafting. The first one of these improved and simplified mills has now been erected at Babcock and Wilcox Tube Co. at Beaver Falls, Pa., under license, and operated with most encouraging results.

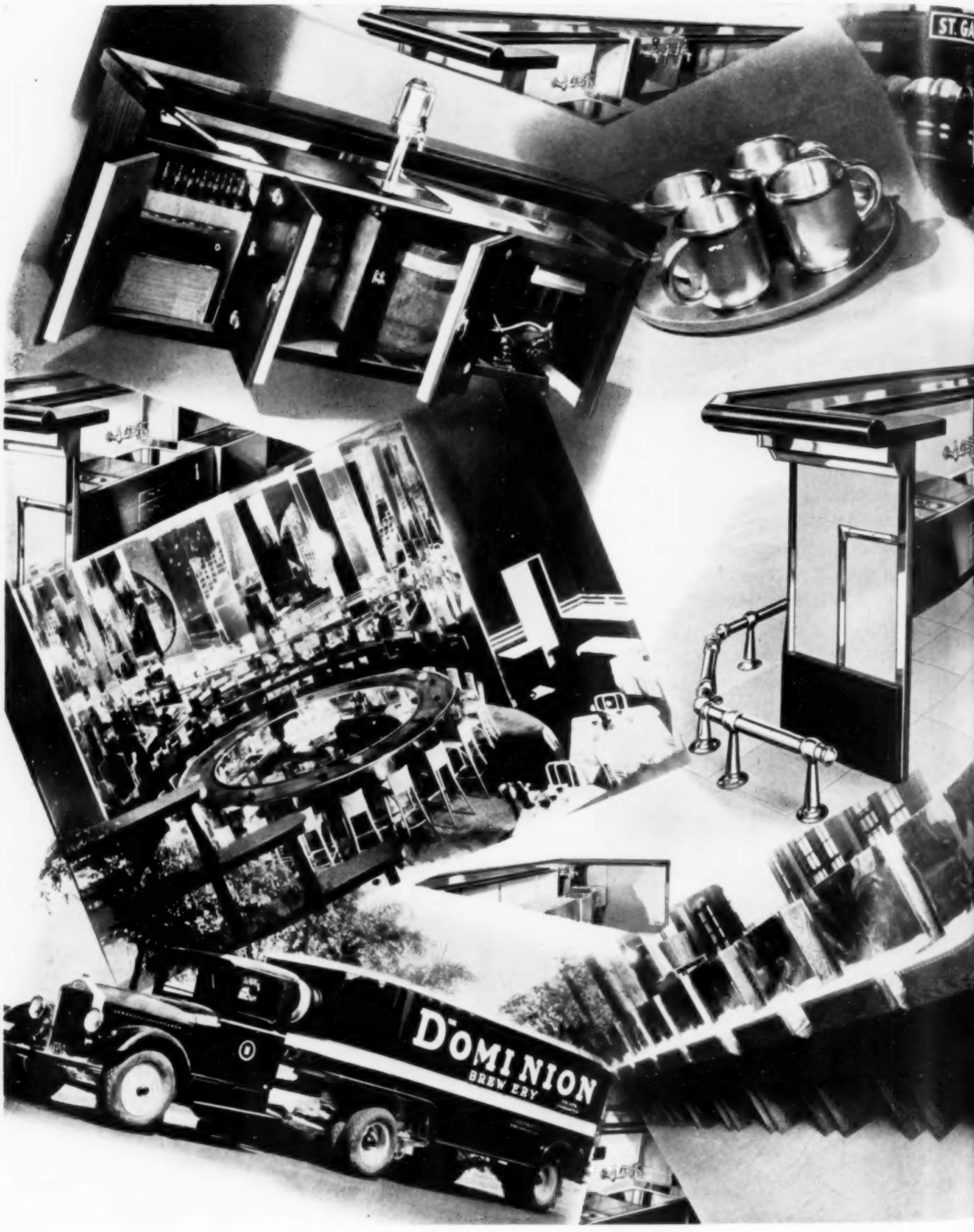
New Mill Makes Tube With Thinner Walls
A short piece of 2 in. x 16 gage tube (the lightest wall made so far on the Diescher mill) inside a piece of 3 in. x 12 gage, the lightest wall made on semi-automatic mill

Tube manufacture is now done on a piercing mill, an "elongator" (which replaces the plug mill, reels and sizing mill in an automatic unit) and a sinking mill when necessary for small diameters on order.

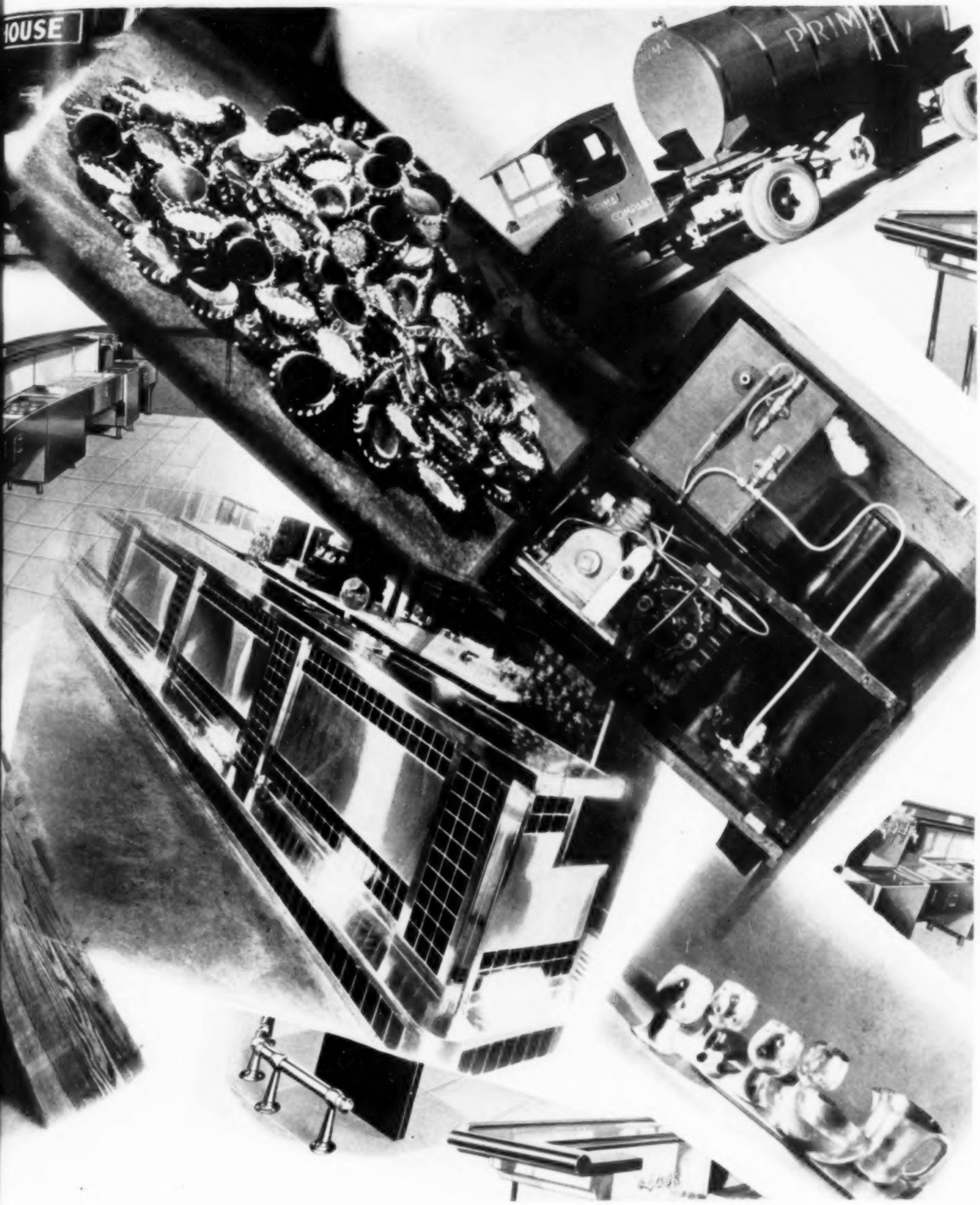
A billet pierced to a relatively thick wall now rolls down in front of the elongator, pauses long enough for the mandrel to be inserted, and is pushed into the mill. The working rolls are set at a slight angle to the horizontal and across each other, and are shaped much like the rolls on the conventional reeling machine. The circular rolls of the plug mill are still in place, but are narrowed up almost to disks, so their contour extends only far enough around to guide the hot tube. The plug, of course, is now a smooth rod mandrel, spinning and traveling forward about as fast as the tube itself. The crossed "work rolls" by themselves would form an oval-shaped tube, but this tendency is prevented by the guiding action of the rotating driven disks above and below. These, by the way, have a peripheral speed of about six times as fast as the work rolls and urge the tube forward, elongating the tube and smoothing out the wave-like irregularities formed during the piercing operation.

Minor changes in dimension are made on the elongator; outside diameter is affected most by adjusting the disks; wall thickness by the work rolls. Changes require perhaps five minutes. It is possible to roll the walls of a tube down to 14 gage (0.083 in.) on the elongator, much thinner than can be done on the old style plug mill before the tube is too cold to work. In one operation the elongator may work out a pierced billet to four times its length, whereas a plug mill could not double its original length in one pass.

Finished tubes are thus made from the billet in two passes. The difference in capital expenditure between an automatic and a Diescher unit for producing approximately the same diameter tubing with comparative production is approximately in the ratio of two to one in favor of the latter. In addition it makes lighter, smoother, and more accurate tubing than that heretofore obtainable in hot rolled seamless products.



Fine Metal for Dispensing Cheer



A CONSIDERABLE tonnage of metals is now being fabricated for use in the distributing and dispensing of beer. Particularly benefited by the American renaissance of an old industry are the stainless steels, nickel, monel, copper and brass. Photographs used in this photomontage were courteously furnished by Apex Electrical Mfg. Co. of a beer cooling and dispensing unit; Bishop & Babcock Mfg. Co. of a draft beer cooler and dispenser; Brunswick-Balke-Collender Co.'s beer bar; Chase Brass & Copper Co. loaned two photographs of copper serving-sets; Crown Cork & Seal Co. of bottle caps; International Nickel Co. of a circular metal bar designed by Joseph Urban; Republic Steel Corp. of stainless and enameled steel bar and stainless steel tank for beer truck; Russ Mfg. Co. an all-metal bar; and White Motor Co. tank trucks.

Low Cost & High Quality in Electric Furnaces

By H. M. WEBBER
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EVERY INDUSTRIAL HEATING PROBLEM involves two major factors — quality of the product and overall cost. Each should receive consideration. Particularly in the matter of cost, recent developments, such as electric furnaces with controlled atmospheres, have introduced new factors having a marked influence on economy. In many instances (where a uniformly treated product is required) the cost of the *heat* per B.t.u. is insignificant in relation to important savings in the heat treatment and subsequent fabrication processes.

In the following discussion it will be recognized that quality depends upon four principal items: (*a*) Accuracy of temperature control, (*b*) uniformity of temperature distribution, (*c*) control of furnace atmosphere, and (*d*) control of both heating and cooling rates.

Cost, aside from quality, includes not only the cost of the energy but also wages for labor, carrying charges (interest and depreciation), maintenance, cost of rejects and subsequent avoidable processing. Included in the cost of energy should be considered the conversion efficiency, the heat absorbents other than the charge itself, and the effect of intermittent operating schedules.

Quality of Product

Accuracy of Temperature Control is of major importance in assuring high and uniform quality of product, especially for duplication of results. It has been achieved in all types of furnaces by coordinating improvements in the art of pyrometry with developments in the auxiliaries for controlling the flow of energy.

Mere control is not all that is needed — *uniformity of temperature* is of equal importance. Because of the low temperature gradient between the heat source and the charge, and because the heating units can be located where desired, the electric furnace can produce the highest uniformity of temperature within the material being heated. For instance, at a plant annealing high carbon steel strip, the maximum temperature variation throughout a stack of coils was found to be plus or minus 10° F. — a feat achieved only in the electric furnace. Uniformity of temperature results in a uniformly treated product, and is one of the major reasons for heating electrically.

Atmospheric Control in the electric furnace is positive and independent of the heat source, a fact which is of tremendous interest to the metal industries for such processes as bright annealing, electric furnace brazing, carburizing and nitriding. Heating and cooling of metals in such a manner as to incur no change in the surface after annealing or stress relieving eliminates subsequent pickling or drying operations. The electric furnace meets this requirement best because in a number of such operations no inner retort is necessary to separate the atmosphere from the heat source.

An article in METAL PROGRESS for October 1931 describes the construction and operation of continuous electric furnaces used for bright annealing punches and stampings of steel, copper, bronze, nickel-silver. The work is carried through the heating and cooling zones on a woven wire alloy belt, protected by a controlled atmosphere until cold. Being discharged clean,

dry and bright, the work requires no pickling or other subsequent finishing operations.

This same equipment is also suitable for electric furnace brazing (actually "coppering"), a method of joining an assembly of steel parts by passing them through a controlled atmosphere furnace and allowing molten copper to flow into the tight-fitting joints. The strength of cam and gear clusters has been increased 50 to 250% by a cash register company by this method, and some attractive cost savings have also been reported — in one instance 60%. The illustration below shows such a box-type furnace to operate with a controlled atmosphere; it has a long cooling chamber at the rear.

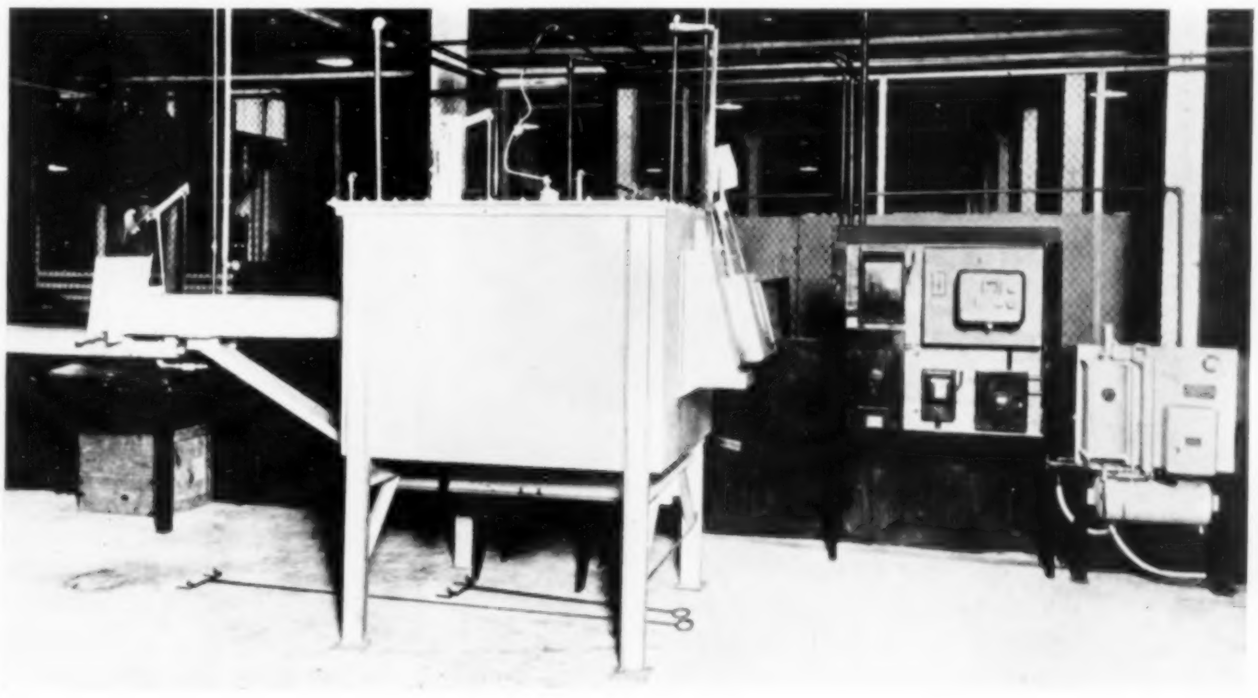
In contradistinction to those atmospheres which are designed to remove oxide but leave the metal surface otherwise unchanged, others add carbon or nitrogen to the steel and produce a hard case. Electric furnaces for economical nitriding were discussed by Mr. Roth in METAL PROGRESS, May, 1932. Pack carburizing in boxes, pushed in double lines through counter-flow furnaces, electrically heated, is a preferred method for recuperating the heat in the cooling mass. Smaller furnaces, usually cylindrical, in which the carburizing atmosphere is a gas (introduced as such or as a liquid hydrocarbon to be vaporized) vigorously circulated by a fan, have been inserted directly into the machine production line, with obvious savings in transportation, coordination, and supervision. A typical installation is described briefly by G. T. Williams in METAL PROGRESS, March, 1932.

The quality of some products is closely associated with the *rate of cooling*. Various means are available for controlling this rate in electric furnaces. The furnace walls would be built of semi-refractory brick of low heat capacity (a variety which gives up its heat readily).

Alloy steel bars are thus cooled at a definite rate through the medium of air-cooled alloy tubes in the upper zone of a pit-type furnace chamber. Silicon steel punchings are cooled in the elevator furnace shown in the view on page 36, at the rate to give best physical and electrical properties, by circulating the protective atmosphere through a surface cooler; 22 hr. are required to bring the center of a 15-ton stack of sheets down to 200° C. from 625° C. as compared with 44 hr. for an equivalent stack under a steel hood cooling in open air.

Another type of bell furnace with a fan built into the base for circulating the atmosphere has been particularly successful in speed-

Cash Register Parts Are Bright Annealed or Copper Brazed in This Box-Type Furnace. Note the cooling chamber at the rear, and atmosphere control equipment at right



ing up the annealing cycle on non-ferrous products, with a gratifying control of grain size in the finished material.

Overall Costs

Cost per B.t.u. of fuel heat is invariably lower than for electrical heat — usually about one-tenth to one-half as much. Why, then, are electric furnaces used where cheap fuels are available? The answer is partly in the low *conversion efficiency* of fuels, which sometimes throws the cost pendulum the other way, and results in a lower heating cost for the more expensive heat.

Another contributing factor is the low *standby losses* of electric furnaces. Annealing boxes, sometimes two or three times as heavy as the charge itself, are done away with entirely in the electric furnace when bright annealing. This not only saves energy, but maintenance, floor space, and dirt. A comparison may be made between the elevator-type furnace shown versus oil-fired pots for annealing steel punchings. The cost reduction was \$0.60 per net ton for energy and \$2.11 per net ton for pots (electricity at \$0.0127 per kw-hr. and oil at \$0.057 per gal. at the burner).

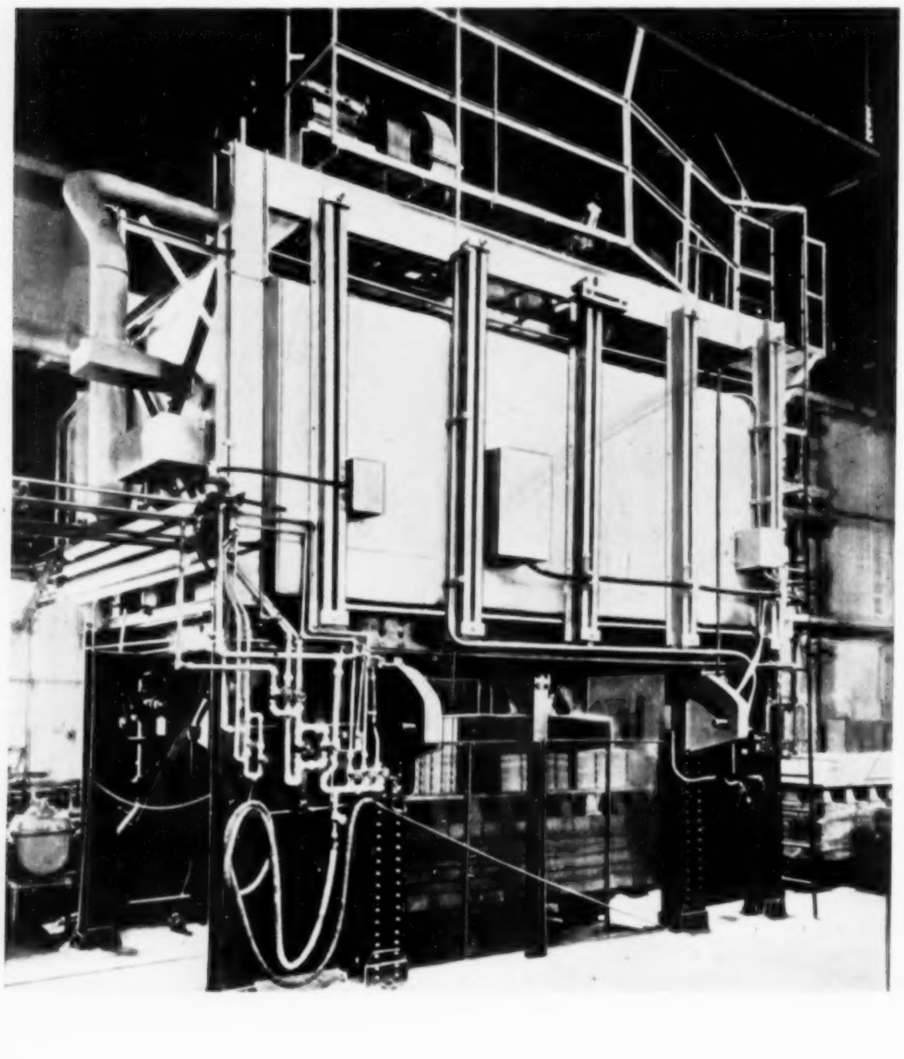
Intermittent Operating Schedules have shown some effects on the cost of operating electric furnaces — in many cases favorable effects. Short annealing cycles are needed for rush shipments, and are thus a distinct sales advantage. This is especially true with the bell-type furnace for annealing cold steel strip; light loads can be annealed quickly at no appreciable increase in unit cost. This feature alone has justified several new installations.

A short annealing cycle for coiled steel strip is made possible by a heating unit which extends from the roof of the furnace down into the center of the stack of coils mounted on a base. A light weight hood of heat resisting sheet rests in a liquid seal in the base, which in turn is made of semi-refractory brick. These two items also have much to do with a rapid and economical anneal.

These same features, along with correct distribution of the heaters along the side wall, produce the utmost temperature uniformity, and the controlled atmosphere within the hoods preserves the finish of the strip, thus adding the final touch to a high quality anneal.

Electric furnaces can often be operated on off-peak power so as to earn a better rate. By studying the plant loads, electric furnaces may be scheduled to operate on cheaper blocks of power, and at the same time reduce the demand charge. Utilities on their part are making an earnest effort to show customers how to improve plant load factors and earn lower rates. For instance, one manufacturer recently ob-

Elevator Furnace for Annealing Silicon Steel Punchings in 15-Ton Lots. Blower recirculates furnace gas through surface cooler, thus speeding the cycle — especially the cooling — to the desirable rate for best electrical properties in the heat treated alloy steel parts



tained a good contract from his power company by installing an electric furnace designed specifically to anneal each day's production of copper wire between 9 p.m. and 9 a.m.

Artificial Atmospheres

It is desirable to eliminate or minimize subsequent operations after heat treatment in order to avoid the cost of extra materials, handling, and injury to the product. The electric furnace lends itself best to this end through the cleanliness or control of the atmosphere and the flexibility of design. Pickling costs are thus avoided by bright annealing. A promising future application is deoxidizing or bright normalizing of steel sheets and strip.

Several inexpensive gases and gas producing equipments are now available. A controller of the combustion type is illustrated on this page. Its function is to burn city gas or natural gas with air, using an abnormally rich mixture (low air-gas ratio); the products of combustion are used as the furnace atmosphere. By control of the input ratio, the resulting gas will be either inert and non-explosive or reducing.

A good gas for bright annealing is formed by burning three volumes of city gas with one of air (resulting in a 3 to 1 output-input ratio). Its analysis is as follows: Carbon monoxide 6%, carbon dioxide 6%, hydrogen 7%, methane 1.5%, and nitrogen 79.5%.

The equipment shown consists of a refractory lined combustion chamber, an automatic proportioning burner, two compressors for maintaining constant input pressure of air and gas, and two meters for checking input, a purifier for removing oxygen and sulphur, and a surface cooler for condensing most of the water vapor from the products of combustion.

As pointed out in an article in METAL PROGRESS in April, 1932, dissociated ammonia forms an excellent source of reducing gas consisting of 75% hydrogen and 25% nitrogen. This gas is strongly reducing and can be burned down to an inert, non-flammable mixture if desired. Ammonia dissociators are simple and rugged, consisting of an electric furnace with side-wall ribbon resistors containing a coiled alloy tube. Ammonia vapor travels through the alloy tube, which contains steel balls acting as a catalyst, and dissociates at the operating temperature of 1500° F.

Another device originated by General Electric engineers produces mixed gas known as "electrolene" from a mixture of city gas or natural gas with water vapor, reacting at about 2000° F. The product is strongly reducing. A typical analysis is carbon monoxide 20%, carbon dioxide 1%, hydrogen 74%, methane 1%, and nitrogen 4%. The equipment contains a cylindrical electric furnace with side-wall ribbon resistors, in which is supported a tubular alloy retort for directing the flow of the gases. It requires little attention after it is started.

There are other inexpensive gases also available for use as controlled atmospheres, and it is thus evident that this phase of a heating problem merely involves the choice of a gas atmosphere most suitable for the job at hand, depending upon the availability of materials, the cost, and the results desired.

It has become obvious that in weighing the value of electric heat for a given application, the ratio of the cost of the electricity to the total cost of the product must be considered. For example, a study of a number of cost sheets shows that this item is within 1/4 of 1% to 3% of the value of the product treated. When viewing the problem from this angle it is seen that a minor improvement in quality, resulting in higher standards of inspection, a reduction of subsequent processes, or a small percentage decrease in rejects will in itself pay the entire cost of electric heat. In this light, the advantages of electric heating assume their true significance, and the influence of new developments on economy is best appreciated.

Device for Making Inert or Reducing Atmosphere by Partial Combustion of City Gas or Natural Gas

ALUMINUM CONSTITUENTS; AS POLISHED AT 500 DIAMETERS

F. Keller and G. W. Wilcox — Aluminum Research Laboratories

Correspondence and Foreign Letters

TURIN, ITALY — Among new metallurgical processes, very few have found in less than ten years such a great variety of technical applications as the nitriding of steel. Its adaptation to so many different technical uses was mainly due to a very extensive and complete study of steels appropriate to the new process. As is well known, the general conditions under which nitriding is now performed are practically always the same. Therefore the only factors affecting the properties of the products to any great extent are the composition and the previous heat treatment of the steels.

Standard Steels for Nitriding

This fact explains why such a great number of nitriding steels have been tested, and why so many of them have been used here and there for nitrided parts.

From a practical point of view, it would certainly be a long step forward in fostering the commercial development of the new process, if it were possible to reduce the number of nitriding steels to a few typical compositions, suitable for the great majority of applications.

A move in this direction has been made in Europe during the last few months, so that at present three grades may be quoted, which include at least 90% of the material used in the industrial countries other than America. (Since there is very close collaboration between the French and Italian nitriding companies, it is natural that technical conditions are substantially the same in both countries.)

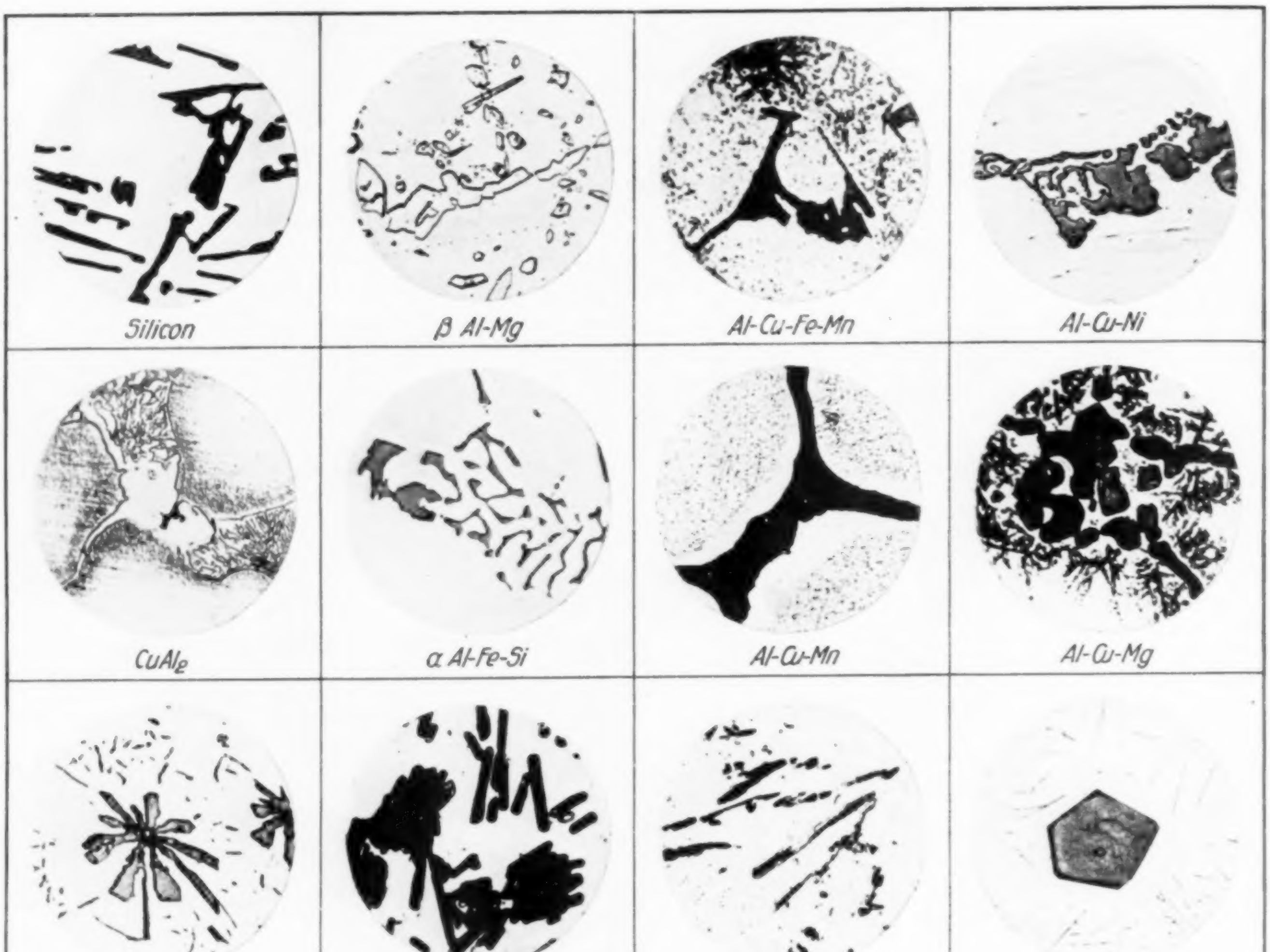
In addition to the well-known nitriding grade of steel first proposed by the originators of the process (containing 1.60 to 1.80% chromium, 0.40 to 0.50% molybdenum, 1.00 to 1.20% aluminum, and various carbon percentages) Messrs. Aubert & Duval Frères of Paris have developed and tested on a very large scale many other steels intended for an enormous number of different applications. A close study of this mass of experimental material accumulated during the last four or five years has permitted that firm to discard a certain number of the proposed analyses, either because in the long run they caused some troubles in use or because other less expensive or more workable steels could be substituted satisfactorily. At present the nitriding steels manufactured by Aubert & Duval Frères (which firm supplies all of these steels used in France) belong to three principal grades.

The first grade I have already mentioned above. It consists of the original chromium-molybdenum-aluminum steels, containing about 1.00% aluminum. These have now found a well-defined field of application for those parts requiring an extremely high superficial hardness, far superior to that obtained with case hardened steels. It may be said that this grade — which at first had found the widest general applications, including parts which had previously been case hardened — is now used on a declining scale and very seldom for replacing case hardening steels.

The second and now most important grade includes chromium-molybdenum-aluminum steels with a lower aluminum content. The composition falls usually within the following intervals: Carbon from 0.35 to 0.45%, chromium from 1.20 to 1.70%, molybdenum from 0.25 to 0.35%, and aluminum from 0.25 to 0.35%. Such steels are used when it is essential to avoid any brittleness of the nitrided layers, and yet necessary to reach a superficial hardness of

Aluminum Constituents Etched in 0.5% HF

Swab with acid for 15 sec.; wash in cold water



F. Keller and G. W. Wilcox *Aluminum Research Laboratories*

Correspondence and Foreign Letters

950 to 1000 Brinell. Their field of application is now the largest, and includes practically all parts where case hardened steels were formerly used. They have excellent machining qualities, and are no more expensive than the engineering steels of corresponding alloy content.

Finally, the last grade includes the nitriding steels without aluminum, in which a higher content of chromium (from 2.20 to 2.40%) and a proper percentage of vanadium (from 0.10 to 0.20%) replace at least partially the hardening or nitriding effect of aluminum. They are used when a superficial hardness of about 850 Brinell is sufficient, associated with great toughness in the surface layers.

Steels of a different composition are nitrided at present only in exceptional cases in France and Italy.

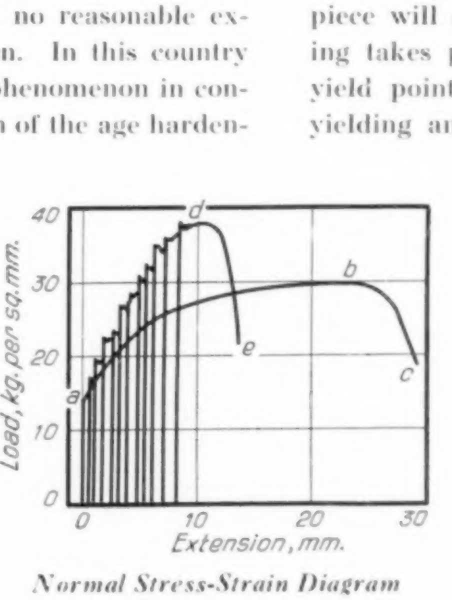
FEDERICO GIOLITTI

(EDITOR'S NOTE: Dr. Giolitti has just published a comprehensive and well-illustrated volume on the nitriding process entitled La Nitrurazione Dell' Acciaio. The publisher is Ulrico Hoepli, Milan, and the price is 60 lire.)

Rapid Aging of Hot Steel Test Piece

SENDAI, JAPAN — The serrated discontinuity on the stress-strain diagram of a steel test piece, pulled at high temperature, has been known for many years, but no reasonable explanation has yet been given. In this country Tadashi Kawai studied the phenomenon in connection with his investigation of the age hardening of cold worked metals and alloys. In the case of metals which age harden after stretching beyond the elastic limit, he found a serrated stress-strain diagram when the testing was done at a suitable high temperature. So he concluded that these rapid fluctuations in load are due to successive yielding and aging.

If a test piece of iron or steel is repeatedly tested immediately after stretching to a permanent set and unloading, no discontinuity will occur at the yield point, but if it is aged before each successive loading, such a serrated discontinuity does occur. The figure below shows the diagram thus obtained for Swedish wrought iron; curve *ade* is of one sample which was aged at 100° C. for 30 min. to accelerate the age hardening, and curve *abc* is one of a sample not aged. Thus, if yielding and aging are alternately repeated, the tracer of a device for drawing automatically a stress-strain line will oscillate considerably upon passing the yield strength.



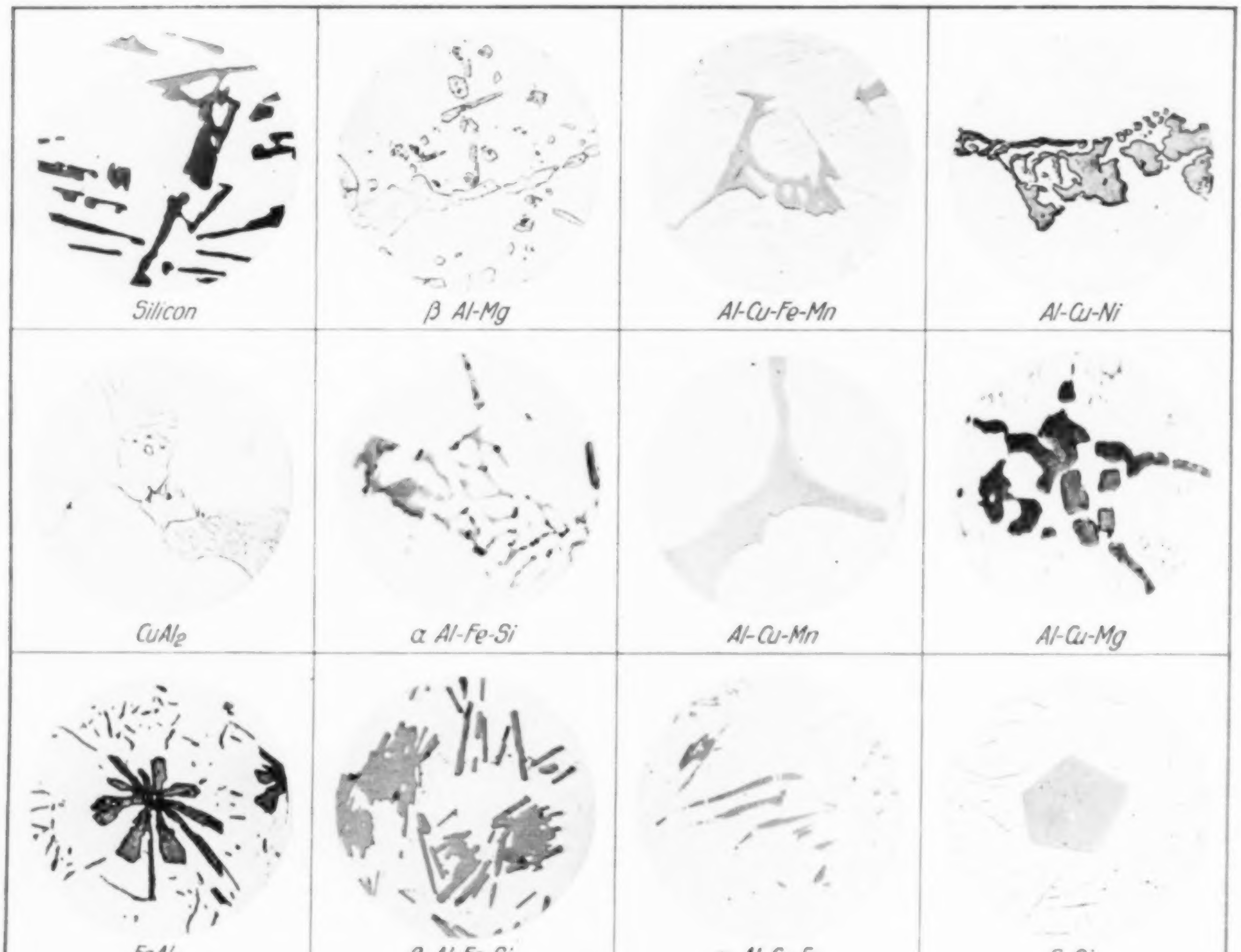
Normal Stress-Strain Diagram of Wrought Iron and Another Showing Elevation of Yield Point by Aging Immediately After Over-Stressing

In a test on iron and steel at high temperature, the velocity of aging is greater than at ordinary temperature and therefore the test piece will age or strengthen as soon as yielding takes place and this aging will raise the yield point. At high temperature, therefore, yielding and aging take place successively in minute steps, resulting in the serration of the diagram, as shown in the second figure. This also applies to any other alloy which age hardens after cold work.

According to the above view, the amplitude and the frequency of the jog on the curve of plastic extension depend on two factors, (*a*) the velocity of yielding and (*b*) the velocity of aging. In the case of iron and steel, both of these factors are very small at a temperature below 80° C. and so no serration is observable provided the test is made at the or-

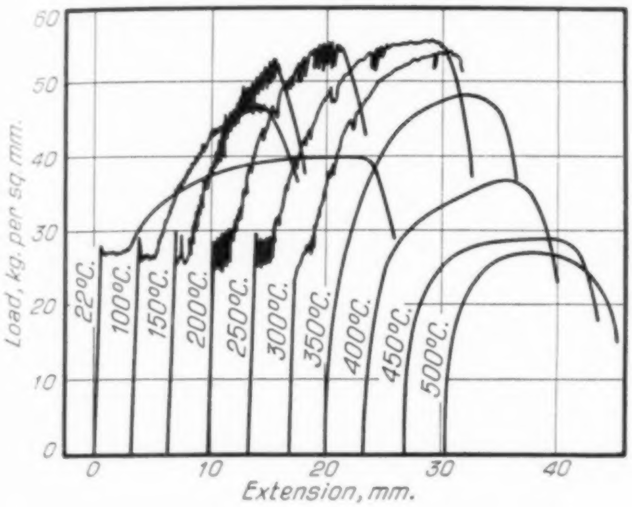
Aluminum Constituents Etched in 1% NaOH

Swab with etchant for 10 sec.; wash in running water



F. Keller and G. W. Wilcox — ***Aluminum Research Laboratories***

Autographic Stress-Strain Diagrams of Iron at Various Temperatures; Normal Rate of Loading



dinary rate of loading. In the temperature range of 100° to 300° C., the serrations are most conspicuous, as the two factors have the most favorable values at these temperatures. Above 300° C. the curve becomes smooth, because at such high temperatures iron and steel are so plastic that a definite yield point cannot be observed in a tension test.

KOTARO HONDA

Correspondence and Foreign Letters

Salt Used to Liquefy Cupola Slag

GROSNY, U.S.S.R. — It is well known to foundrymen that the cupola should discharge a liquid rather than a sticky slag, since it aids in raising the quality of the cast iron, increasing its temperature, decreasing the melting losses, and also in lowering the fuel consumption and increasing the output.

A sticky slag, on the other hand, is liable to plug the tuyeres and prevents the use of high sulphur coke. While limestone is usually the flux, it is sometimes difficult to obtain a liquid and low-melting slag with it. In such cases the question of using other kinds of flux for diluting the cupola slag has to be considered. Fluorspar or open-hearth furnace slag is the common "medicine."

At the present time this question is of great importance in the Soviet Union owing to the low quality of the available coke and firebrick and the dirtiness of the metallic charge which ordinarily must be melted. Fluorspar is very expensive, and must be imported into our country. Besides it corrodes the lining. Open-hearth slag is insufficient in supply, and it does not greatly influence the condition of the cupola slag.

The foundry department of the Scientific Research Institute has developed a method whereby common salt — sodium chloride — is used for this purpose. It is cheap and gives a more fusible slag than that obtained by using fluorspar or open-hearth slag.

Experiments along this line were carried out in Moscow in 1932. When using limestone alone, a very viscous slag was frequently formed, whereupon the addition of common salt to the charge quickly restored normal conditions. At the same time the melting efficiency of the cupola was raised. This was done without adding to the weight of slag; when limestone alone was used as flux the slag was 6% by weight of the iron charged, whereas it weighed only 5.8% when common salt was added to the limestone.

At the Podolsk machine shops (near Moscow), where open-hearth slag had been used to dilute the cupola slag, ten smelting tests were made on a Whiting cupola with a continuous tap. They proved the main points already noted, namely that under normal working conditions the addition of common salt to the cupola greatly increased the fusibility of the slag, and raised the melting efficiency, even at a decreased blast. Corrosion of the lining was not increased, in fact decreased if anything.

During the experiments it was observed that the lining was covered with an enamel from the melting zone to the throat opening, which indicates that sodium chloride used for diluting the slag rather reinforces than corrodes the lining.

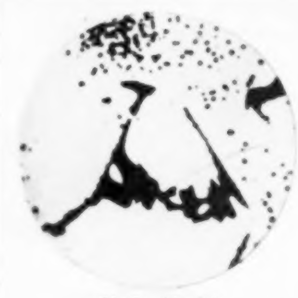
B. M. SUSLOV

Aluminum Constituents Etched in 20% H_2SO_4

Immerse in acid at 70 C. for 30 sec.; quench in cold water

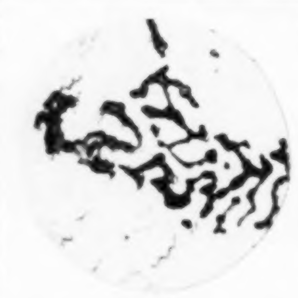

Silicon

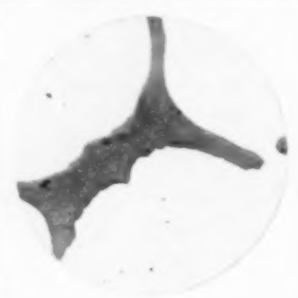

β Al-Mg

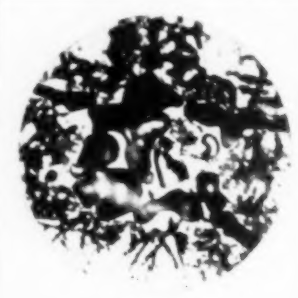

Al-Cu-Fe-Mn


Al-Cu-Ni


$CuAl_2$


α Al-Fe-Si

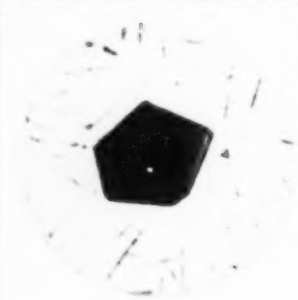

Al-Cu-Mn


Al-Cu-Mg


$FeAl_3$


β Al-Fe-Si


α Al-Cu-Fe


$CaSi_2$


Al-Mn


$NiAl_3$


β Al-Cu-Fe

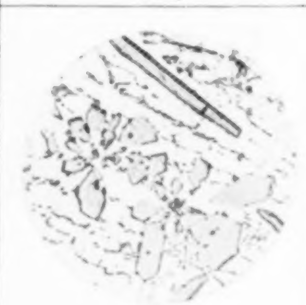

$CrAl_7$

Pl. VI


Mg_2Si


Al-Fe-Mn


Al-Mn-Si


Al-Cr-Fe

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PARIS, FRANCE — Inclusions in steel and their elimination appear more and more as fundamental problems to the metallurgists who busy themselves with high grade steels. Such inclusions act not only by their proportion, their size and distribution in the metal, but also by their nature — in fact, their influence may be very different according to their chemical composition and their atomic arrangement.

Thus the properties of hot steel are not influenced in the same way when the inclusions contained in that steel are fusible (such as oxide and sulphide eutectics) and when they are refractory (alumina or silica). Even in cold metal the influence is profound. To take only one instance, the perfection of polish may depend upon whether the inclusions, such as hard silicates and chromite or soft sulphides, may be polished without breaking, or, on the contrary, according to the brittleness of crystallized silica, or titanium cyanonitride or oxide, which hinders polishing of the surface, or even prevents an approach to the desired degree of smoothness.

Formation and Evolution of Inclusions

One main type of inclusion may be dismissed with a mention: Those that come from the furnace walls, the ladle linings, and trapped furnace slag. Such inclusions are generally big, scarce in number, and not in chemical equilibrium with the surrounding metal.

The important type are indigenous; they are inclusions found in the heart of the metal, arising from the chemical reactions that have taken place on the spot. These inclusions are generally very fine ones. They must be considered as internal slags that form a scattered phase of fine particles in the liquid metal and are in chemical equilibrium with it. Such a chemical equilibrium depends on the temperature and on the concentration of the various elements of the bath. From this statement we may derive three important causes of inclusions:

1. *Chemical variation* of the metallic bath — that is to say, the modification of its content either of "impurities" such as oxygen, sulphur, and nitrogen, or of its alloying constituents.

2. *Thermal variation* within the metallic bath — cooling is usually accompanied by formation of inclusions. *(Continued on page 62)*

Correspondence and Foreign Letters

SCHWEINFURT, GERMANY — To determine whether oxygen content influences the tensile strength of steel, it was decided to study some soft steel tubing, welded in an oxy-acetylene tube-welding machine, wherein the flame was adjusted to contain various proportions of oxygen and acetylene. Whether oxygen is a strengthener or weakener has been speculated upon so often that the answer should be of interest to readers of METAL PROGRESS.

Basic mild steel strip with the following composition was used: Carbon 0.05%, manganese 0.45%, silicon traces, phosphorus 0.07%, sulphur 0.04%. It had a tensile strength of 55,000 lb. per sq.in. and 22% elongation.

Smoother, more uniform welding is secured with the higher proportions of oxygen to acetylene. On the other hand it must be admitted that this produces a strongly oxidizing welding atmosphere which causes the steel to take up oxygen and thus changes its properties. The question is, "How much is the metal weakened?"

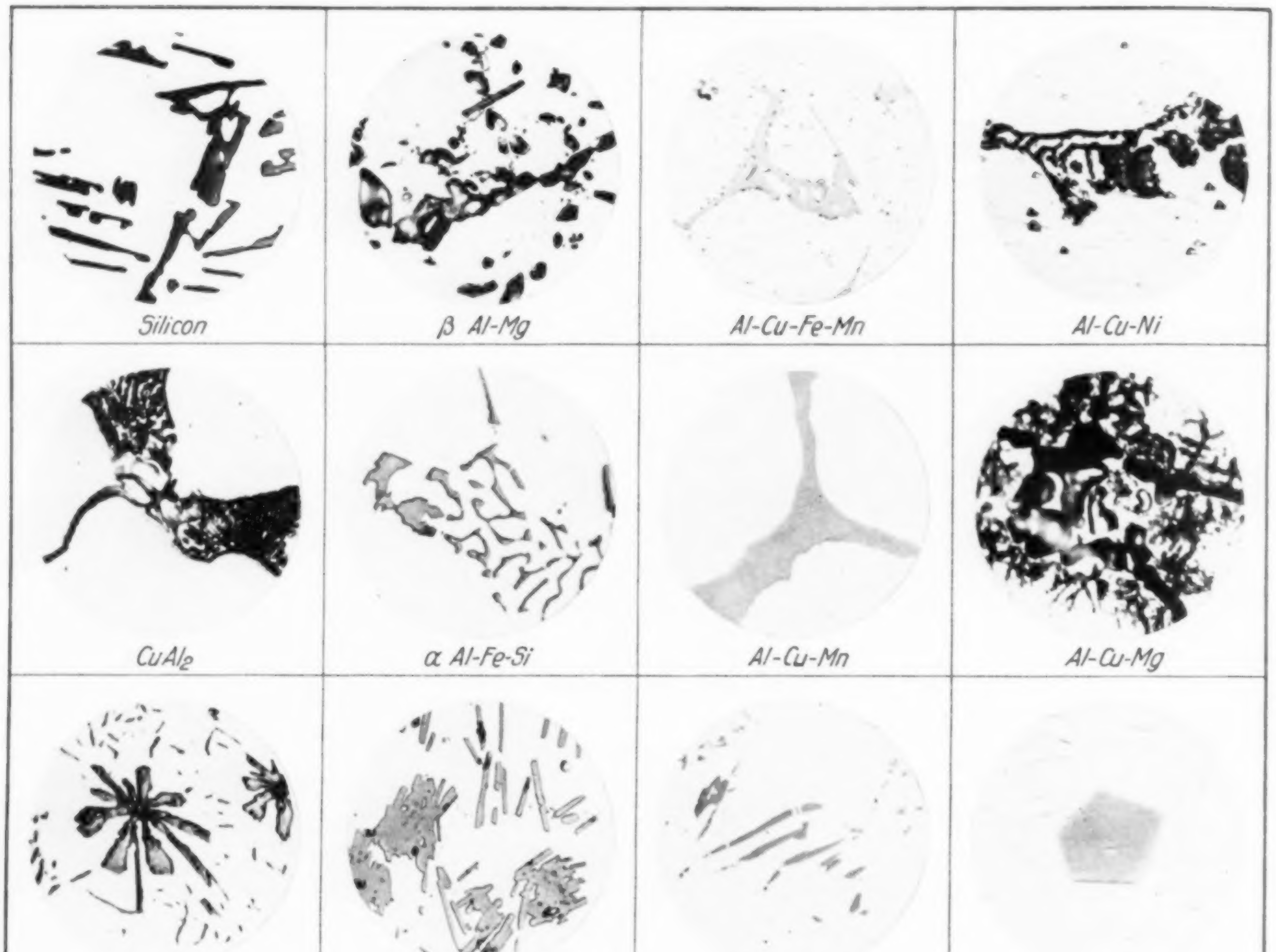
Strength of Welds High in Oxygen

Tubing is nearly always stressed by pressure from within. Tensile tests were therefore made in the fixture shown in the sketch on the next page. Each jaw was split down its center and when assembled pressed tightly against the walls of the tube, leaving the welded seam exposed at one side. In almost all the tension tests the weld cracked, and only these values are taken into consideration.

Tubing was welded with the flame adjusted so the ratio of oxygen to acetylene was 0.9, 1.0, 1.1, and so on up to 2.1. Average of a number of tension tests on tubes made with each flame condition, when plotted against the gas ratio,

Aluminum Constituents Etched in 25% HNO_3

Immerse in acid at 70° C. for 40 sec.; quench in cold water



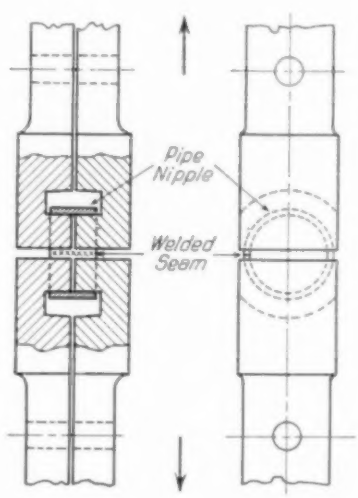
F. Keller and G. W. Wilcox *Aluminum Research Laboratories*

Correspondence and Foreign Letters

showed a horizontal straight line at about 63,000 lb. per sq.in. (the dotted line in the curve). The range was 59,000 to 66,000 lb. per sq.in.

It would appear, therefore, that the strength of machine welded tubing is not affected by the oxygen-to-acetylene ratio at the blowpipe.

It may be noted in passing that this result is in contrast to the former studies on the properties of samples welded by hand. For instance, Dr. Mues found a distinct maximum in ultimate strength and elongation when the ratio of oxygen to acetylene was 1.0 to 1.2, and Dr. Heyn found a similar maximum in the stiffness (bend test).



Fixture for Testing Longitudinal Welds in Tube

The next thing was to prove that the tube samples which had equal strength, yet were welded in different flames, actually contained different quantities of oxygen. Since determinations by the vacuum melting method give correct values for oxygen only when small test pieces with highly polished surfaces are used, strips 8 mm. wide were cut out of the tube wall with the welded seam longitudinally in the middle. These strips were further cut into 30-mm. pieces for analysis. Determinations were made in a carbon spiral furnace at 1420° C. and a pressure of 0.0014 mm. of mercury, and also at 1500° C. and 0.0008 mm. of mercury. In the absence of aluminum and silicon, all the oxygen found came from FeO or small amounts of MnO. Quantitative reduction and correct determination of both oxides undoubtedly occurs under the above-mentioned conditions of temperature and pressure.

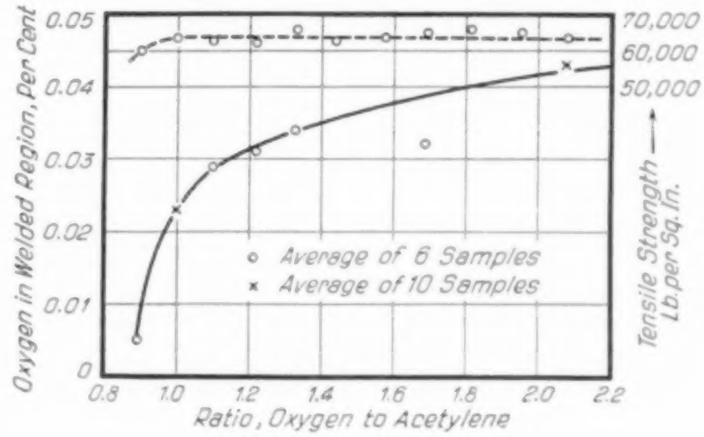
The results of the experiments are shown in the curve. Increasing the oxygen in the welding flame has a marked influence on the oxygen of the weld. Indeed the average oxygen in ten steel samples is doubled when the ratio of gases in the flame increases from 1 to 2. This is an "oxidizing atmosphere." On the other hand, a sharp decrease of oxygen content of the weld occurs when oxygen to acetylene in the flame is less than 1. This is a "reducing atmosphere."

If the welded seam alone were analyzed — which was not the case with samples 8 mm. wide — the difference would certainly be more distinct, for the unmelted steel next to the weld tends to neutralize the effect.

The gases given off at 1500° C. analyzed 0.018% oxygen and 0.0050% nitrogen. This amount of nitrogen was found to be the same in the other tests.

Since the strength of the welded steel remains the same while the oxygen content rises sharply, it may be assumed that under the conditions described above the tensile strength is not affected by oxygen in steel.

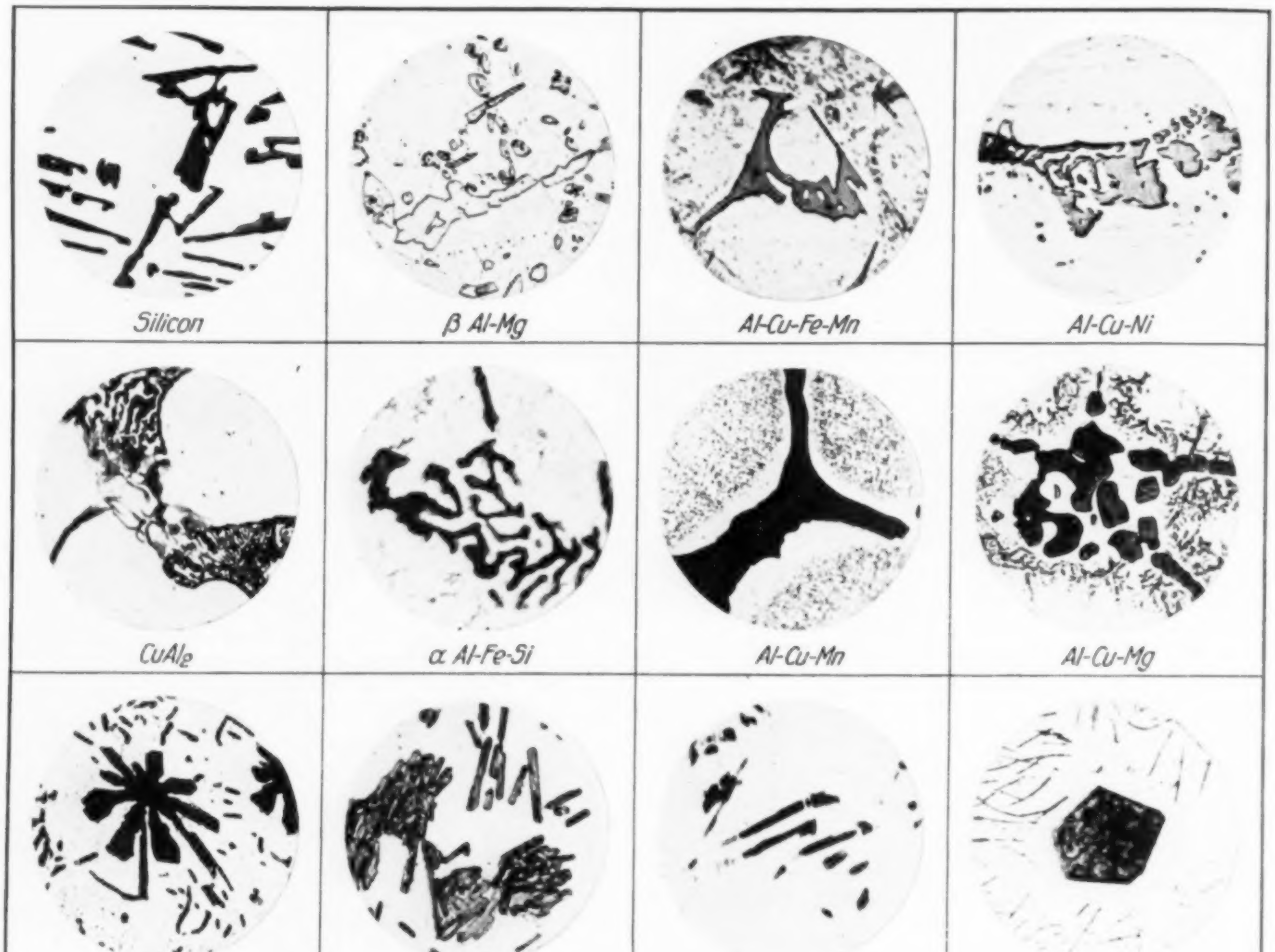
The proportion of gases in the welding flame has a noticeable effect on the carbon content as well as on the *(Continued on page 60)*



Relationship Between Strength (Dotted Line) and Oxygen in Metal (Full Line)

ALUMINUM CONSTITUENTS ETCHED IN 10% NaOH

Immerse in etchant at 70 C. for 5 sec.; rinse in cold water



F. Keller and G. W. Wilcox — *Aluminum Research Laboratories*

Concentrates from current literature

THE 131-lb. per yd. rail described by T. J. Skillman in METAL PROGRESS, November, 1931, has been named a standard by the American Railway Engineering Association, superseding unused 120, 140, and 150-lb. standards. According to *Engineering News-Record*, March 30, this represents the final answer to the old controversy as to whether it was better to roll a **RAIL** with a deep head giving the most metal for wear, or one with a rather shallow head, light enough so the work of rolling would improve its wear resistance. The latter idea has been proven correct by the Pennsylvania railroad, whose section is the result of an exhaustive study and has been tried out in 1½ years' service in heavy tonnage tracks. It is also interesting to note that the older Pennsylvania engineers have been the most vigorous exponents of the deep headed rail.

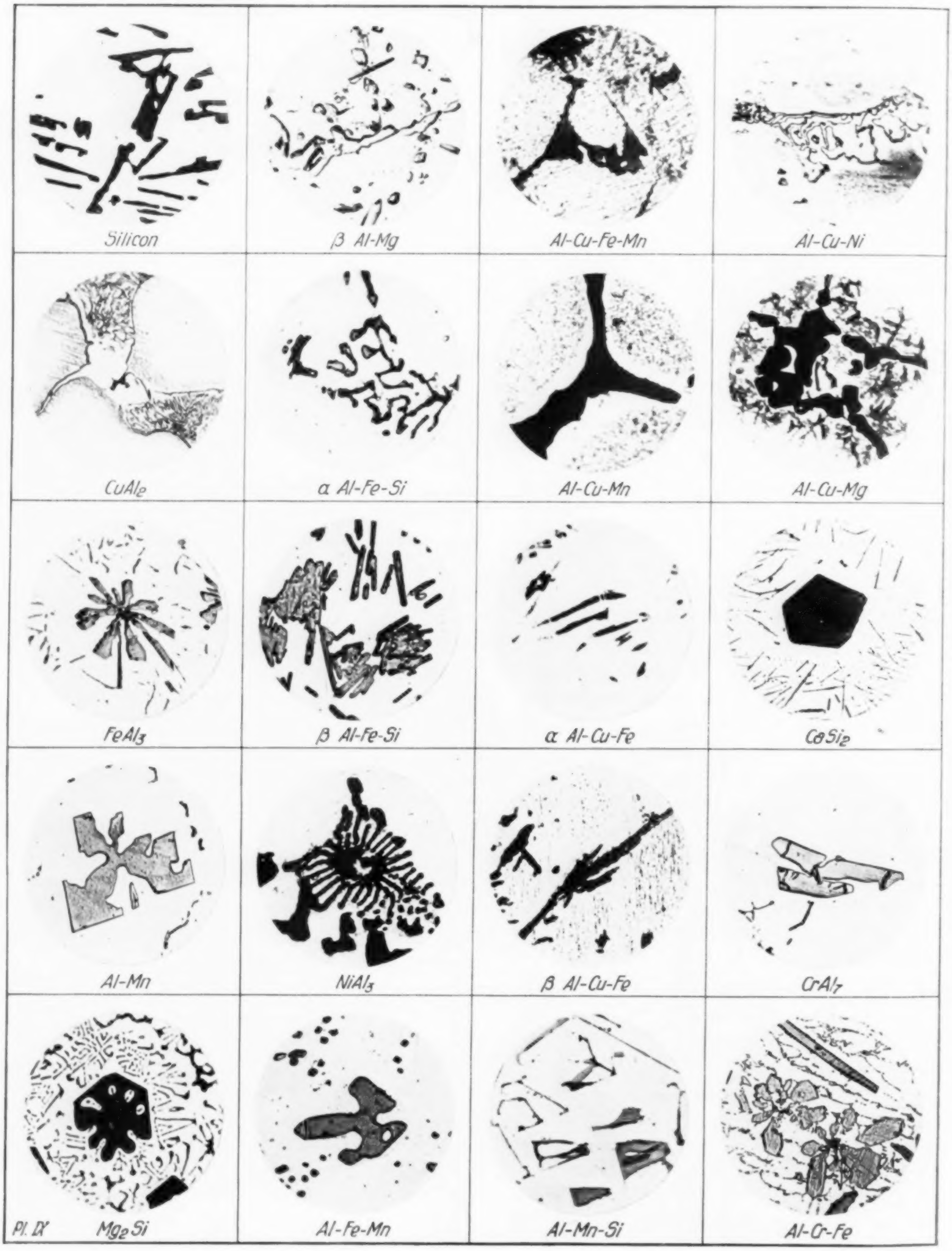
A METHOD for the economical production of high-grade electric steel from scrap is described in *Steel* for March 13. It was developed by H. M. Naugle and A. J. Townsend, and produces a fine-grained, non-dendritic steel, free from pipe, by centrifugal casting into a rapidly revolving circular mold. The resulting steel ring is sheared along longitudinal elements into blooms, ready for a three-high breakdown mill. Since the temperature at this point is 2000° F., only a short heat is necessary before rolling. The yield of **CENTRIFUGAL CAST BLOOM** is about 98%, as compared with 80% in blooming mill practice, where the pipe must be cropped. By eliminating the blooming mill, steel may be made in smaller lots as required by the consumer and by the use of an all-scrap charge, and the plant located at the point of consumption. Economies thus effected, as well as savings afforded by the high yield of high-grade product, are expected to compensate for the expense of the electric furnace.

TYPES of high speed equipment with which railroads hope to recover lost passenger business are described in *Railway Age* for April 8 and 16. The 180-mile trip from Berlin to Hamburg is done in 2 hr. 20 min. by a two-car train, with a common truck at the articulated joint. 400-hp. diesel engines and electric generators are mounted low-down on front and rear trucks, and furnish power to motors geared to both axles of the center truck. **PASSENGER CAR** body has a frame welded of light structural shapes, and covered with 0.08-in. sheets. Truck frames are welded of rolled steel. Following automotive practice, each wheel has a brake drum; each brake band is operated with its own air cylinder. The train carries 100 passengers, seated as in Pullman sections, and weighs about 1640 lb. per passenger.

In this country experiments tend rather to aluminum and stainless steel construction. As an example of the former, the **AUTOTRAIN** applies much of today's automotive design. It is a single car unit about half the length of the "Flying Hamburger" described above, and has a Cadillac V-16 engine, mounted under a hood at the front, geared to both of the front truck axles. The car frame is made of rolled and extruded aluminum alloys and sheathed in the same metal. Seating is as in a club car; fixed windows and air conditioning are features. Weight is 720 lb. per passenger. Rubber cushioning is used extensively, even between aluminum wheel disks and steel treads.

Aluminum Constituents Etched in Mixed Acid

Immerse in HF-HCl-HNO_3 for 15 sec.; rinse in warm water



F. Keller and G. W. Wilcox — *Aluminum Research Laboratories*

Concentrates

A FOUR-HIGH cold rolling mill, constructed by E. W. Bliss for American Sheet & Tin Plate Co. is to be used for rolling plate up to 84 in. wide to a tolerance of 0.00025 in., with reductions of 40 to 50% per pass (*Steel*, March 13.) Working rolls are 20 in. diameter, backing rolls 56 in., and roll pressure 13,000,000 lb. Instead of the customary castings, it was decided to make roll **HOUSINGS OF FORGED STEEL PLATE** to provide the rigidity, resistance to deformation, and equality of stretch in both housings necessary for such close tolerance and high pressure. The housing resembles an elongated link, 31 ft. 10 in. long, 10 ft. 3 in. wide, and 34 in. thick. The window of the housing, is 5 ft. 1 in. wide, leaving a post section 31x34 in. The final design chosen provides for four $8\frac{1}{2}$-in. slabs welded together to make the required thickness of 34 in. Laminations of 1 to 2-in. plates, welded on the edges, were first considered but scrap loss in the windows would be too expensive. By the use of thick slabs, the window can be used for further housing sections.

TWO general assembly methods may be used in the erection of welded storage tank shells, according to H. C. Boardman in the February *Welding Engineer*. In the Belgian system the bottom is fabricated first, then the top ring and roof. This is jacked up and the next rings are welded successively under the top one, all work being done on the ground. The lower edge of each ring is fitted around a system of guides tacked to the bottom plates to retain the correct shape. In the second method of **WELDING A TANK**, commonly used in the United States, the lowest ring is assembled first against guides tacked to the bottom plate, the plates plumbed, and nuts or seating devices welded on the inside at correct lapping distance below the top edge and fixed distance from the bottom. The next ring is set on the nuts and tacked in place, although if it does not fit evenly, no effort is made to force it. Vertical joints are made in the same way, although a line drawn on the plate and a horseshoe frame may be substituted for the nuts. The seams are left open until the entire ring is assembled, and except for tacking, no welding is done until the entire shell is assembled. A more complicated job is the construction of a pontoon-type roof, which requires a supporting structure, upon which the central plate disk, bottom plates, channels for the inner walls of the pontoon, bulkheads for liquid and gas partitions, rim plates for outer walls, and trusses for stiffening the pontoon are erected in turn.

WORKABILITY of steel sheet of deep drawing quality involves the ability to be stamped into shape without developing "worm" markings or **STRETCHER STRAINS** in the surface — irregularities too deep to be hid by subsequent lacquer or enamel coverings. It has long been known that this type of workability was greatest immediately after cold rolling, when the steel was in a state of cold plasticity, so-called, and this advantage gradually was lost with age. Some sheet metal workers would therefore put sheets through a roller leveler immediately before stamping them into difficult forms. (See Winlock and Lavergne, METAL PROGRESS, Sept., 1931.) A special device for the purpose is described in *Steel*, April 24, combining the Guibert method of the McKay Machine Co., and the Kelley method of Edward G. Budd Mfg. Co. The sheet enters a pair of hold-back rolls and then a double pair of pinch rolls; openings in all three are placed in a single plane, but have a gap in the setting between first and second in which a depressed idling roll is set. When the sheet is well gripped this idling roll is forced upward, causing the sheet as it travels forward to be flexed upward in the path of an inverted U, thus giving it the desired amount of alternate bending to produce a cold plastic state. Passing out from the pinch rolls, the sheet is fed into a roller leveler, and is ready for immediate stamping and pressing.

THAT aging is greater in cold worked materials or quenched materials and that aging increases rapidly with moderate increase in temperature are two observations made by R. W. Carson in *American Machinist*, March 29. His theory is that increasing the temperature allows certain unstable zones in the metal to overcome the decreased viscosity and be brought slowly

Concentrates

to equilibrium. Further temperature increase permits more rapid internal readjustment, but as unstable conditions approach equilibrium, the aging rate diminishes. This is substantiated by curves illustrating experiments on springs and other types of steel. Some recommended heat treatments for **AGING SPRINGS** are: Phosphor bronze, 100° C. for 15 hr.; hard drawn brass, 120° C. for 10 hr.; hard drawn nickel, nickel silver, and monel metal, 150° C. for 8 hr.; low carbon steel and low alloy steel, 200° C. for 5 hr.; high carbon steel, nickel steel, and stainless steel, 300° C. for 5 hr.

CLIMAX Molybdenum Co. has published several annual reviews of the technical literature about "moly" in irons and steels. Lately the importance of the alloy to gray iron foundries has warranted a special publication, and a 1933 foundry supplement is now available. It digests recently acquired information in a running story. Prominence is given to comparative tensile tests on single heats of irons, made by various foundries in various furnaces, to part of which **MOLYBDENUM** (often with nickel and chromium) has been added. Other data are presented on heat and wear resistance, hardness, and impact and compressive strength.

SIX muffle furnaces consisting of a 14½-ft. nichrome tube, 2 in. diameter, slightly flattened, and 0.1 in. wall thickness, which serves as the "susceptor" in an induction heater, have recently been installed by a manufacturer of **RAZOR BLADE** steel. The inductors of the furnaces (described by E. F. Northrup in *The Iron Age*, Feb. 23) are thin-walled copper tubing, water cooled, wound to operate at a temperature of 1500° F. The turns per inch are increased 1 ft. from the exit end to raise the temperature to 1600° F. 92 lb. per hr. are heat treated in the six furnaces. Operating cost amounts to $5 per 1000 lb.

Heating of chromium plated tubes by induction to about 1850° F. has also been found to improve the cohesion and quality of the plating.

(Continued on page 58)

ASK FOR THESE USEFUL PAMPHLETS

Tool Steel

A concise folder just issued by Ludlum Steel Co. gives complete information on Saratoga, an oil hardening, non-shrinking tool steel. Full specifications are given for the proper heat treating of this steel, including directions for forging. Bulletin My-94.

"Vee-less" Arc Welds

New literature covering a very recent development in arc welding has been prepared by Metal & Thermit Corp. Known as Murex Straight Gap welding, the new process eliminates grooving or "veeing" the edges even of heavy plates. Welding time is halved and other savings are effected, it is claimed. Bulletin My-64.

Stainless Steels

Republic Steel Corp. offers detailed descriptive literature on the subject of its line of Enduro stainless steels, a series of low-carbon stainless alloys with chromium content ranging from 4 to 30%, and with or without other alloy additions of nickel, molybdenum, tungsten or other elements. Bulletin My-8.

Which Cast Iron?

A novel and very valuable self-reading chart for anyone interested in cast iron has been compiled by International Nickel Co. The device recommends analysis and heat treatment and gives physical properties for cast irons suitable for 50 different applications. Bulletin My—45.

Turbo Compressors

A series of three bulletins is available from Spencer Turbine Co. describing their Turbo Compressors for oil and gas fired equipment and foundry cupolas. Sizes range from 100 to 2,000 cu. ft., 1 to 300 h. p., 8 oz. to 5 lbs. Bulletin Fe-70.

Phosphor Bronze

American Brass Co. has issued a beautiful pamphlet which describes the commercial forms of Anaconda Phosphor Bronzes, a series of deoxidized copper alloys containing up to 10% tin, notable for high tensile strength and resistance to fatigue, corrosion and wear. Bulletin Fe-89.

Super Blowpipes

The advent of natural gas has made the replacement of many burners imperative. American Gas Furnace Co. describes in an illustrated folder blowpipes, ribbon burners, cross-fires, hand torches, etc., which are suitable for use with natural gas, propane and butane. Bulletin Ja-11.

Big-End-Up

Gathmann Engineering Co. briefly explains the advantages of steel cast in big-end-up ingots, showing the freedom from pipe, excessive segregation and axial porosity. An 82% ingot-to-bloom yield of sound steel is the usual practice. Bulletin Fe-13.

How to Test Wear

Tests of lubricants or of wear of moving parts may be made accurately with a new machine, made by Timken Roller Bearing Co. A bulletin tells how the machine tests the load carrying capacity of lubricants and measures the friction and wear of materials. Bulletin M-71.

Cyanides and Salts

Metallurgists will find valuable information in an 80-page booklet published by R & H Chemical Department of E. I. du Pont de Nemours Co. Technical information on the heat treatment of steels with cyanides and salts is presented in a lucid manner. Bulletin D-29.

Atmosphere Furnaces

A new folder issued by Surface Combustion Corp. gives performance data on their atmosphere furnaces compiled from installations in actual production. Operations described include bright annealing of ferrous and non-ferrous metals, carburizing, nitriding, forging without scale and hardening without scale. Illustrated. Bulletin Ap-51.

Cut Forging Costs

An 8-page reprint has been issued by Electric Furnace Co. which illustrates various types of automatically controlled continuous, semi-continuous and batch type forging furnaces and shows the advantages and savings effected by the installation of modern forging furnaces. Bulletin Ja-30.

To Prevent Rust

The well known rust preventive, No-Ox-Id, is now available from Dearborn Chemical Co. as a foundation for paint. It is available in the colors red, gray or black. A booklet explains how maximum resistance to corrosion can be obtained. Bulletin Ju-36.

Micro-Metallograph

Metallurgists will be interested in the description of the Leitz Model MM-2 Micro-Metallograph. This simplified instrument at low cost provides all essential optical and mechanical equipment to meet the requirements of industry. Bulletin Fe-47.

Extensometer

A simple but rugged extensometer has been developed by Union Carbide & Carbon Research Laboratories. A booklet describes how it works and how to use it for determining either yield point or as a strain gauge to show elongation under specified load. Bulletin Ma-63.

Recuperators

The complete story of recuperators built by Carborundum Co. for industrial furnaces is told in a readable booklet. The range of types available is described and the operating conditions are outlined in a clear manner. Bulletin F-57.

300 Stainless Uses

Stainless steels are undoubtedly the most widely used of the alloy steels, according to the very interesting booklet on this subject just issued by Electro Metallurgical Co. Over 300 industrial uses of chromium and chromium-nickel steels are described in considerable detail. Attractively illustrated. Bulletin Ja-16.

Tilting Pot Furnaces

American Electric Furnace Co. has prepared a description of its series of low temperature tilting pot furnaces specifically designed for melting babbitt, etc. Cast-in immersion heating elements are used. The furnaces are especially fast and may be easily moved about the plant. Bulletin My—2.

Pickling Inhibitors

A pamphlet describing the nature and use of Grasselli Inhibitors is available to all those interested in the pickling of steel. It not only describes the merits of these inhibitors, but it gives a table of suggested inhibitor strengths to be used in the pickling of the various grades of steel. Bulletin Ap—95.

Cast Vanadium Steel

Jerome Strauss and George L. Norris have written a technical booklet for Vanadium Corp. of America describing the properties developed by steel castings containing various percentages of vanadium. The information given is complete and authoritative. Bulletin S-27.

Globar Elements

Globar electrical heating units and a variety of accessories for their operation have been catalogued by Globar Corp. A list of the standard industrial type heating elements and a coordinated list of terminal mountings and accessories is included. Bulletin N-25.

Furnace Parts

Various parts for furnaces made from alloys manufactured by Driver-Harris Co. are pictured and described in an interesting publication. Complete performance data and specifications of Nichrome and Chromax heat resisting alloys are given in the booklet. Bulletin N-19.

Refractories

A semi-technical booklet prepared by Norton Co. gives valuable information on the manufacturing processes and the various industrial applications of fused alumina (Alundum), silicon carbide (Crystolon) and fused magnesia refractories products. Bulletin J-88.

Liquid Baths

A competent discussion of liquid baths for heat treating steel at temperatures from 350 to 1800° F. appears in a recent publication of E. F. Houghton & Co. A valuable chapter is devoted to the proper design of furnaces for use with liquid baths which lists 20 general furnace requirements. Bulletin Ja-38.

Scleroscopes

The model D standard recording scleroscope is described and illustrated in a recent publication of Shore Instrument Co. The theory and practice of hardness testing with this portable machine as described in this bulletin reveal a fund of valuable facts. Bulletin S-33.

X-Rays in Industry

General Electric X-Ray Corp. has available a profusely illustrated brochure entitled "Industrial Application of the X-Ray", which gives the complete story of the field of application of this modern inspection tool. Valuable information is presented. Bulletin Ma-6.

Low Cost Recorder

Inexpensive dependability in measuring and recording temperature is the great asset of the new Leeds & Northrup round chart Micromax indicating recorder which brings the reliability and easy maintenance of the motor-driven null recorder to a new low cost. Bulletin Ap—46.

Heat Resisting Alloys

Authoritative information on alloy castings, especially the chromium-nickel and straight chromium alloys manufactured by General Alloys Co. to resist corrosion and high temperatures, is contained in one of that company's publications. Bulletin D-17.

Heat Distribution

The advantages gained by uniform temperature distribution throughout furnace charges are fully described in a publication of Westinghouse Electric & Manufacturing Co. In properly designed electric furnaces, heat can be accurately distributed and controlled, with resultant great savings in cost. Bulletin MP-5-33

Stainless Sheets

A very useful booklet describing the stainless steel sheets and light plates made by American Sheet & Tin Plate Co., gives recommendations for fabrication and a description of finishes and analyses available. Bulletin Ap—96.

Closer Heat Control

Anticipatory control action may be obtained with any pyrometer controller by adding the Deoscillator developed by Foxboro Co. A new folder tells how the device prevents over-controlling by augmenting the thermocouple E.M.F. when the temperature is low and opposing it when the temperature is high. Bulletin Ap—21.

Titanium in Steel

An elaborate catalogue prepared for technical readers describes the use of ferro-carbon titanium in steel. Titanium Alloy Manufacturing Co. prepared it. The application of titanium in steels for forgings, castings, rails, sheets and plates is thoroughly described. Bulletin J-90.

Heating Units

An unique and very useful device for calculating heating units when figuring coiled units, covering wattages from 275 to 1000, has been prepared by Hoskins Mfg. Co. Two slotted cards are clamped back to back through which various data can be read by adjusting a card which slides between. Bulletin D-24.

Heat Treating Data

Brief but accurate summaries of the proper treatments for annealing sheets, wire, welded tanks, malleable castings and forgings are given in a book published by Brown Instrument Co. Normalizing, tempering, hardening and carburizing recommendations as well as many special treatments are included. Bulletin Fe-3.

Fatigue Testing

That much discussed topic — fatigue testing — is covered in a publication of Thompson Grinder Co. Interesting data on fatigue of metals and a description of the rotating beam type of fatigue testing machine are presented. Bulletin D-23.

METAL PROGRESS,
7016 Euclid Ave., Cleveland.

Please have sent to me the following literature as described in the May issue. (Please order by number.)

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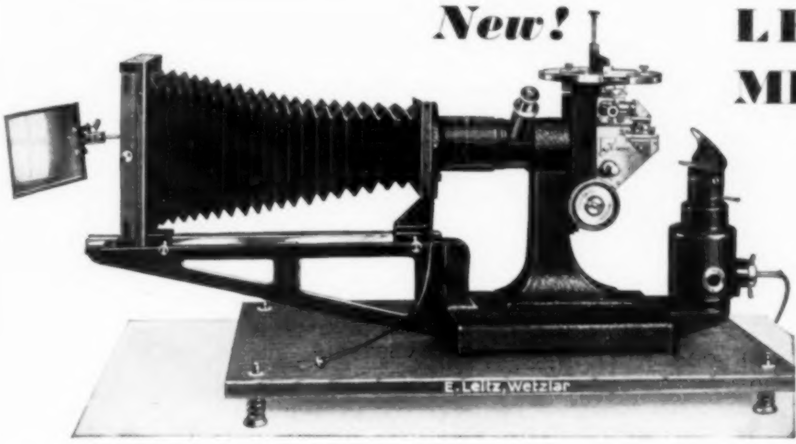
The tube acts as "susceptor" and is slowly advanced by revolving asbestos disks through a short induction coil. A generator which is also used for melting high grade steel supplies the necessary high frequency current.

METAL spraying, as the process has been improved to date, consists of melting fine wire in an oxy-acetylene flame, atomizing it by means of an air gun, and projecting the molten particles at a speed of 33,000 ft. per min. onto a surface previously roughened by sand blasting. The whole unit for **METALLIZING** weighs about 2 lb. New applications are discussed by Charles Stipp in *The Welding Engineer* for March. One of these is the spraying of automotive engine combustion chambers with aluminum, for its high heat conductivity. Spraying welds in galvanized sheets where the zinc has been burned off is another use. Castings can be salvaged by filling blowholes and surface defects, worn parts can be built up to size, and expensive glass-lined tanks for bromine salts can be patched with tantalum.

A NEW type of finish for aluminum is provided by dyeing, as described in *The Iron Age*, March 2. The completely fabricated metal product is electrolytically oxidized as in deplating, and is then transferred to a vat of either organic or inorganic dye, which penetrates the surface to a depth of 0.0003 to 0.001 in. A high luster is obtained by polishing or buffing. Two **FINISHES** may be obtained: Grade A, which is hard and resistant to wear and weathering, and grade B, which is softer and may be applied to aluminum sheet which is to be further drawn or bent into the finished product. A design may be provided by covering the desired areas with a gilsonite composition which protects the metal surface from the dye. A wide range of colors is possible, although those mixed with a large proportion of white are not so successful. The color has more brilliancy and depth than lacquer or enamel, but costs from 50 to 100% more. The dye is not entirely satisfactory on alloy castings.

New!

LEITZ MICRO-METALLOGRAPH



Simplified Model "MM-2"

NOTE: *The Leitz Darkfield Equipment and the new series of Leitz Objectives (corrected for infinity) are supplied with the Simplified Micro-Metallograph 'MM-2'.*

The Inverted Microscope and Camera of Micro-Metallograph Simplified Model "MM-2" represent a modified as well as simplified construction of the well known Leitz Micro-Metallograph Large Model "MM-1" which is so successfully used for micro-analysis of metals. The purpose of offering the Simplified Model "MM-2" is *to provide at the lowest possible cost an instrument including all essential equipment both in optical and mechanical respects that meets the entire range of practical requirements from carbon-iron alloys to metals of every variety.*

The New Instrument fulfills a demand which has hitherto existed for micro-metallographic equipment arranged in its construction to meet the efficiency known to exist with the large Micro-Metallograph, however, in price so arranged, that industrial and educational laboratories with a moderate purchasing budget can be accommodated.

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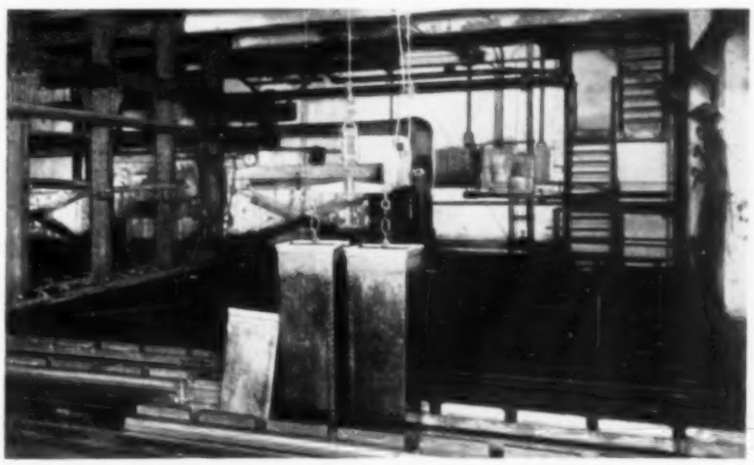
How the Ice Industry Combats Corrosion of Steel in Brine Tanks



When dealers in "antiques" of modern manufacture wish to rust and pit iron and steel into semblance of antiquity, they often immerse it in salt water. They have no use for NO-OX-ID.

But ice manufacturers must immerse their freezing cans in brine and efficient operation dictates, "no rust." They have great use for NO-OX-ID. Every plant in Buffalo, N. Y., uses it. Thousands of plants the world over use it and the verdict is that for long-lived effectiveness, ease of application and low first cost, NO-OX-ID wins.

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Correspondence

(Cont. from page 47) oxygen content. For instance, a flame with an excess of acetylene (ratio 0.89) raises the carbon content at the center of the weld in 0.05% carbon strip to 0.27%. This is shown metallographically and by Rockwell hardness tests. It is supposed that the slightly lower strength concurrent with much higher carbon and hardness in welds made with "reducing flames" is explained by a very irregularly distributed carbon content.

It may be concluded that the proportion of oxygen to acetylene in a machine welding blowpipe should not be under unity. On the other hand, because hand welding with a flame having a ratio between 1.0 and 1.2 oxygen to acetylene gives welds with the highest tensile strength, a similar mixture should be regarded as best to use with machine welding. Nevertheless, it is best to stay in the upper range.

HANS DIERGARTEN

Correspondence

3. *Solidification*, which changes the concentration of the various elements in the liquid phase, owing to the crystallization of solids whose chemical composition is different from the mother liquor.

All these causes may interact so as to modify the nature and the chemical composition of inclusions previously formed in the metal. Since the equilibrium between inclusion and metal is very unsteady, any modification of the metal during refining has its own influence on the nature and the proportion of inclusions. To give one example only, we may say that a micrographical study of samples taken during the refining of a mild basic steel showed that every variation of the oxygen or sulphur content not only modified the proportion of sulphides, oxides, and oxy-sulphides, but also the variation in manganese content modified the composition and the form of the same oxides and sulphides, because it also varied their manganese content. During carburization of the bath the quantity of oxides decreased, but on the other hand, the addition of silicon caused silicates to appear, and the further addition of aluminum formed alumina inclusions when the quantity of aluminum in the metal was sufficient, or, if insufficient, the formation of silico-aluminates (which are similar to the mineral garnet).

In fact, one may observe every stage of the operation and draw up a table showing the parallel between the modifications of the chemical composition of the metal and the modifications of the nature and composition of the inclusions. This mutual influence is not observed when inclusions are made artificially and incorporated into the melted iron. This has frequently been done in the past. Of course, the special elements of steel (more particularly chromium, tungsten, and molybdenum) give particular oxidized or sulphuretted combinations.

From a practical point of view, this explains how some variations in the operating methods may have a large influence upon the quality of the metal.

ALBERT PORTEVIN

METAL PROGRESS

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W. H. Eisenman, Secretary
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